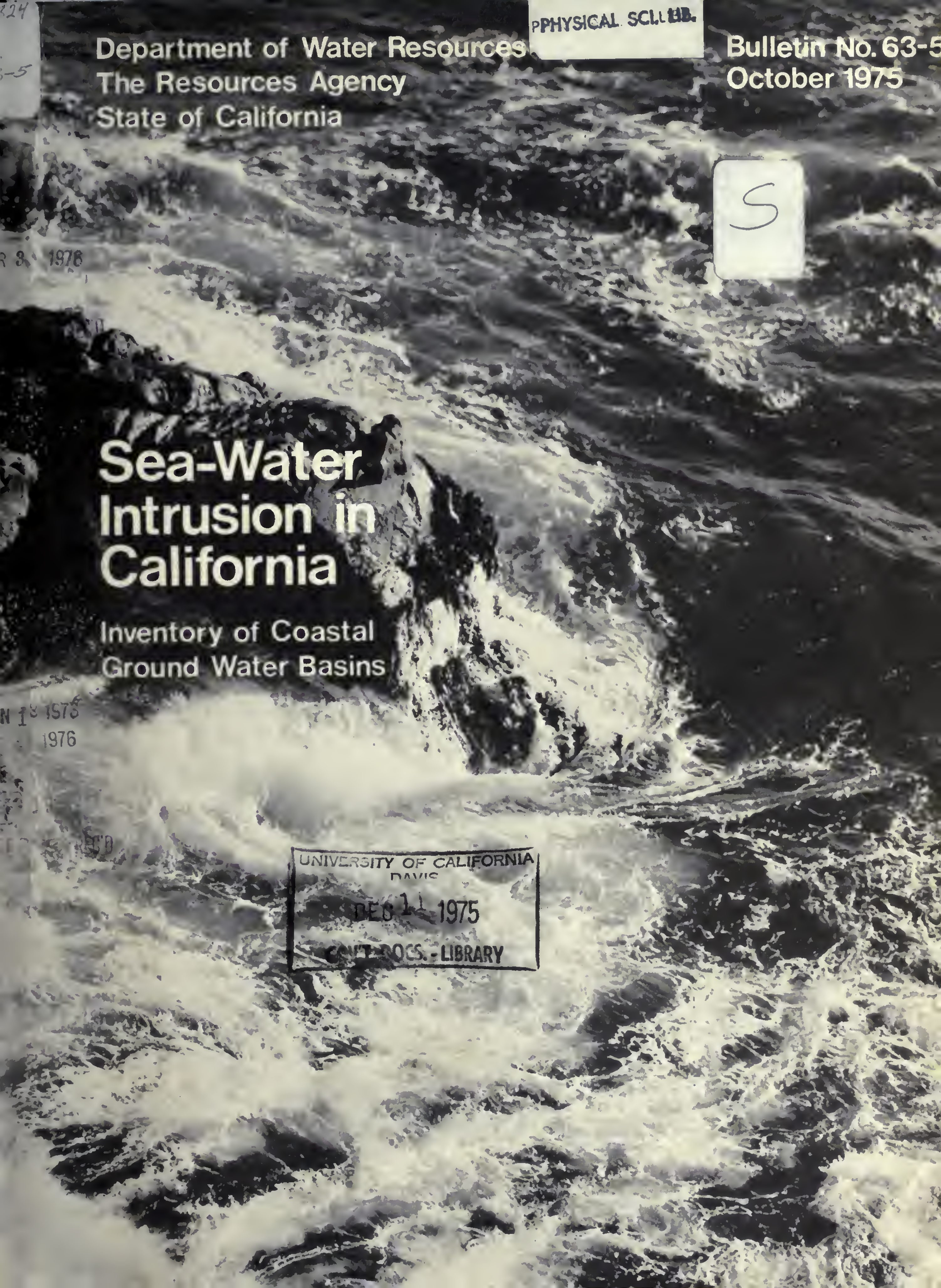
Department of Water Resources
The Resources Agency
State of California

Bulletin No. 63-5
October 1975



Sea-Water Intrusion in California

Inventory of Coastal Ground Water Basins

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Resources Agency

State of California

Department of
Water Resources

Claire T. Dedrick
Secretary for Resources

Edmund G. Brown Jr.
Governor

Ronald B. Robie
Director

FOREWORD

The ground water supply of many urban communities adjacent to the coast of California is threatened by underground intrusion of saline water from the Pacific Ocean. This condition exists whenever ground water levels have been drawn down below sea level. To assist local agencies that must cope with this threat, the Department of Water Resources continually monitors wells in these areas to determine whether sea water has intruded the ground water basin. This is accomplished by testing the salt content of water samples from wells and measuring the fluctuation of water levels in wells.

The primary purpose of this bulletin is to show, as completely as available information permits, the present status of sea-water intrusion, to the end that local agencies can decide where they must take steps to reverse the condition. A corollary purpose is to show the need for more information on intrusion in certain areas where the situation is particularly critical.

This study was undertaken solely to determine the extent and location of sea-water intrusion into coastal basins and to compile an inventory that would assist local agencies in assessing the water supply conditions in their areas. It was not designed to arrive at any specific conclusions or recommendations for on-site control of intrusion in individual basins.

This effort is planned to encourage the formation of a cooperative statewide program to monitor coastal ground water basins. It is anticipated that the Department of Water Resources will meet with local agencies to develop such a program. As a minimum, it will require ground water quality sampling and measurements of water levels in wells. The Department recommends that coastal basins having known or suspected intrusion should be monitored at least every one to two years; basins containing high chlorides of doubtful origin should be monitored at least every three years; and the remaining basins should be surveyed about every five years.

Ronald B. Robie

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Department of Water Resources
The Resources Agency
State of California

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Edmund G. Brown Jr., Governor

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SEA-WATER INTRUSION STUDIES BY THE DEPARTMENT OF WATER RESOURCES

Bulletin No. 63 Series

This series of reports, which has been prepared for use by the Legislature, government agencies, and the general public, discusses the physical characteristics of California's coastal ground water basins, including geology and ground water hydrology and water quality, status of sea-water intrusion, methods of control, experimental studies, and preliminary plans for prevention and control of intrusion.

Bulletin No. 63, Sea-Water Intrusion in California. November 1958. 91 pages.

Appendix A, Status of Sea-Water Intrusion. November 1960. 233 pages.

Appendix B, Sea-Water Intrusion in California; Report by Los Angeles County Flood Control District on Investigational Work for Prevention and Control of Sea-Water Intrusion, West Coast Basin Experimental Project, Los Angeles County. March 1957. 141 pages.

Appendix C, Part I, Laboratory and Model Studies of Sea-Water Intrusion. 44 pages.

Part II, An Abstract of Literature Pertaining to Sea-Water Intrusion and Its Control. 72 pages.

Part III, Review of Formulas and Derivations for the Equilibrium Rate of Seaward Flow in a Coastal Aquifer with Sea-Water Intrusion. 13 pages.

Appendix D, An Investigation of Some Problems in Preventing Sea-Water Intrusion by Creating a Fresh-Water Barrier. 82 pages.

Appendix E, Preliminary Chemical-Quality Study in the Manhattan Beach Area, California. 34 pages.

(Appendixes C, D, and E were published in April 1960 as a single volume.)

Bulletin No. 63-1, Sea-Water Intrusion, Oxnard Plain of Ventura County. October 1965. 78 pages.

Bulletin No. 63-2, Sea-Water Intrusion, Bolsa-Sunset Area, Orange County. January 1968. 167 pages.

Bulletin No. 63-3, Sea-Water Intrusion, Pismo-Guadalupe Area. February 1970. 76 pages.

Bulletin No. 63-4, Sea-Water Intrusion: Aquitards in the Coastal Ground Water Basin of Oxnard Plain, Ventura County. September 1971. 569 pages.

A joint study by State of California, Department of Water Resources, and University of California, Department of Civil Engineering, Geotechnical Engineering, Berkeley.

Bulletin No. 63-6, Sea-Water Intrusion: Morro Bay Area, San Luis Obispo County. February 1972. 104 pages.

Several other significant sea-water intrusion studies have been presented in other reports published by the Department. They are listed below.

Bulletin No. 81, Intrusion of Salt Water into Ground Water Basins of Southern Alameda County; December 1960.

Bulletin No. 147-1, Ground Water Basin Protection Projects: Santa Ana Gap Salinity Barrier, Orange County (Final Edition); December 1966.

Bulletin No. 147-6, Ground Water Basin Protection Projects: Oxnard Basin Experimental Extraction-Type Barrier; September 1970.

Sea-Water Intrusion, Lower Salinas Valley; Progress Report, 1968-1969; June 1970. 28 pages.

Sea Water Intrusion and Ground Water Monitoring Programs in the Eureka Area; Northern District Report; June 1973. 17 pages.

Sea Water Intrusion, Lower Salinas Valley Monterey County; San Joaquin District Report; July 1973. 91 pages.

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Alameda County Water District

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Orange County Water District

San Luis Obispo County Flood Control and Water Conservation District

Santa Barbara County Flood Control and Water Conservation District

Santa Clara Valley Water District

United Water Conservation District

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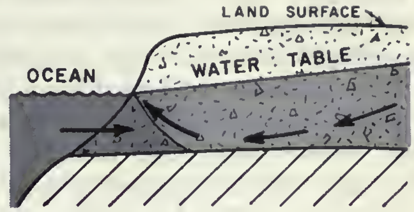
California Department of Parks and Recreation

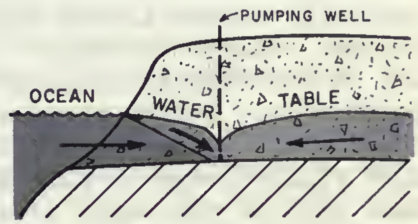
SEA-WATER INTRUSION IN CALIFORNIA GROUND WATER BASINS

Chapter I. THE SEA-WATER INTRUSION PROBLEM

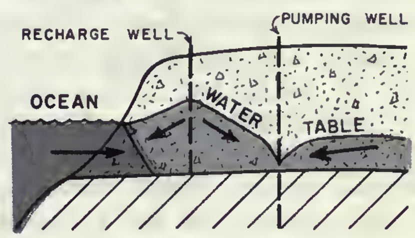
For the past 50 years, California has been gradually losing part of its natural underground supply of fresh water as the ocean has invaded coastal ground water basins from Oregon to Mexico. Sea water has already infiltrated 14 important basins and is suspected of seeping into 14 others.



NATURAL CONDITIONS



SEA-WATER INTRUSION



A SOLUTION

This silent but devastating invasion has caused deep concern in both urban and rural coastal areas for many years. Since about 1900, Californians living there have relied on wells that tap the ground water supply. As the state's population grew and the need for water increased, more and more wells were sunk. In time the earlier abundance of artesian water began to decline and, as the underground supply of fresh water dwindled, wells were drilled deeper and pumped more heavily, with the result that the ground water levels in wells in certain basins fell to critical points below sea level. Wherever this occurred, ocean water entered the basins, and those who depended on pumped ground water found their once-fresh supply becoming brackish and unusable. In some areas, the pumped water has become saltier year by year.

As long as a basin is undisturbed by man, no problem exists because the fresh ground water flows toward the sea and the sea water is restrained (top). However, when water is pumped from the basin (center), the natural balance between fresh and salt water is upset and sea water enters the basin. Sea water will continue to move inland as long as the water table remains below sea level and slopes toward land. This landward movement can be arrested only by returning ground water levels to near-natural conditions (bottom). Once saline water has entered a basin, fresh water in the infiltrated portion is no longer available as a source of potable water. Efforts to restore this degraded water to an acceptable level of quality may require many years.

Responses to the sea water problem in the 14 basins that are known to be intruded have varied. As the saline water has slowly but inexorably traveled inland, degraded wells have had to be abandoned and sealed and new wells drilled elsewhere. Some southern California communities have found it necessary from time to time to impose water rationing while they looked for other sources of fresh water. In a large coastal basin in Los Angeles County where intrusion was first noted in 1932, heavy pumping has allowed sea water to encroach along the entire coastline from Santa Monica Bay south to the Palos Verdes Hills. To control this intrusion, an elaborate underground barrier has been created by injecting large amounts of fresh water into wells in the ground water formation along an 11-mile coastal stretch. This effort has now either stabilized or reversed the inland movement of sea water.

Another critical area lies in the southern end of San Francisco Bay. Intruding salt water was first noted there in 1924.

Continued heavy ground water pumping from the basin during the past 30 years has allowed saline intrusion. In the past decade recharge activities and water purchased and imported from the State Water Project and the city of San Francisco have reduced the amount of salt water entering the basin. Studies are currently under way to develop a pumping barrier that will further restrain saline encroachment.

Sea-water intrusion continues to be a critical problem in the Pajaro and Salinas Valleys in Central California and in the Oxnard Plain in Southern California. Local agencies are well aware of the problem and over the years have studied ways of alleviating it. Some work is now being done to recharge the forebay areas and to bring supplemental water to these basins.

The current status and magnitude of sea-water intrusion in smaller basins in Humboldt, Marin, Napa, Sonoma, San Luis Obispo, and San Diego Counties and in the 14 small basins in which intrusion is suspected are not clearly defined, but the situation could become acute, should ground water extractions be either continued or increased.

In coastal areas three conditions signal the beginning of an intrusion problem: when water level elevations fall below sea level, when landward hydraulic gradients are established, and when mineral constituents in well water increase. The separate or combined occurrence of all three mean that corrective steps must begin if the saline invasion is to be repelled.

Potential Protective Measures

Several methods of proven value in halting or restraining sea-water intrusion exist, but before any of them can be used, the unique advantages or disadvantages of each must be assessed in relation to the physical and hydrological status of a basin. Various methods of control (illustrated in Appendix D) are summarized here. Some of them will apply to all basins, and some will apply only to certain basins because they require additional water unavailable to an area, are too costly to build and maintain, or are not geologically feasible. This report is not intended to recommend use of any specific method, because agencies may find any one or more of them is suitable. If local agencies do not implement corrective measures, the State of California may then enter the situation. The State Water Resources Control Board has authority (under Section 2100 of the Water Code) to use adjudication procedures when ground water basins are in trouble. The Board can file an action in Superior Court to restrict pumping, or to impose physical solutions, or both, to the extent necessary to prevent destruction of or irreparable injury to the quality of the water.

Water conservation is a method that is applicable to all basins. Reducing demand reduces the amount of water that must be pumped from a ground water basin. Successful application of this method depends on convincing all water users in an area of the urgent need to use less water.

Limitation of ground water extractions is a method that is applicable to basins in which other sources of water could be developed. These alternative sources could include imported water, locally-developed surface or ground water, and reclaimed waste water.

Use of reclaimed waste water to recharge ground water is a method that is applicable to basins where sources of waste water exist. Adequate provision for insuring high quality water for recharge must be incorporated to minimize health risks.

Sea-water intrusion can also be controlled by various physical on-site methods. One of these is a physical barrier, which involves construction of an impermeable membrane between the ocean and the pumping wells. This method is gen-

erally suitable only in small coastal basins with a relatively thin layer of water-bearing materials. Morro and Chorro Basins in central California and San Luis Rey Valley in southern California are good examples. Use of a physical barrier permits considerable latitude in managing a basin. Water levels may be drawn down significantly, for instance, permitting use of large amounts of stored fresh water, or the gradient from an area of recharge may be steepened, providing more water.

Another method of on-site control is artificial recharge by surface spreading. This is usually done in permeable forebays lying far inland. It requires additional water in sufficient quantity and of suitable quality for an extended period and at reasonable cost. This method is most applicable to large coastal basins such as Santa Clara and Salinas Valleys, the Oxnard Plain, and coastal plain areas of Los Angeles and Orange Counties. These basins have extensive permeable forebays suitable for recharge and well-defined permeable aquifers capable of transmitting and storing large amounts of ground water.

Use of the pumping trough is another on-site control method applicable to any basin. It requires continuous maintenance of a line of control pumping wells between the ocean and the water supply wells. Installing and operating these wells is costly and, unless demand exists for the mix of saline and fresh water produced, much usable water is wasted. Monitoring ground water levels at the pumping trough and determining the amount of water to be pumped at the control wells are two essential factors.

In the injection barrier method, applicable to any basin, fresh water is injected into the basin through a line of injection wells separating the ocean and the pumping wells. This method requires an alternative supply of water. The injected water creates a pressure barrier that restrains the landward advance of sea water and allows great flexibility of water level fluctuation below sea level in the inland area. In Fountain Valley (Orange County), "Water Factory 21" is now producing high-quality water from a blend of reclaimed waste water and desalted sea water. The blend is injected into fresh water stored in the Orange County Coastal Plain ground water basin to block intruding sea water and to replenish the basin's supply. In Palo Alto (Santa Clara County), a study is under way in which reclaimed waste water is being injected into a salty aquifer to determine the most effective way to reclaim waste water and inject it into a ground water body.

Imported water must often be used for artificial recharge and injection barrier methods of intrusion control. A disadvantage inherent in imported water use is its cost. Also, in the past the project operator importing the water usually could not prevent its being pumped from the basin by local water users. The recent California Supreme Court decision in Los Angeles v. San Fernando, 14 Cal. 3d 199 (1975), will greatly facilitate use of imported water since it holds that the importer has a prior right to such water. This holding should enable the importer to prevent such water from being removed from the basin by local water users and would also give the importer a prior right to recover such water and sell or use it for his own purposes.

A combination barrier, applicable to any basin, controls intrusion by combining the pumping trough and injection barrier techniques. In this method, a pumping trough is operated on the ocean side of the pumping wells and an injection barrier is operated on the landward side. Only about one-third as much water must be extracted as with a pumping trough alone, and a smaller amount of fresh water must be injected to achieve the same result achieved with an injection barrier. A combination barrier offers great flexibility in managing a ground water basin for intrusion control.

The Investigation

This report evaluates the status of sea-water intrusion in the 263 known ground water basins along California's coast. Results of field work of 1970-1971 appear as basin inventories, beginning at Chapter III.

Findings

All larger coastal ground water basins supply significant amounts of water.

Intrusion is known to exist in 14 basins.

Intrusion is suspected in 14 more basins.

Degraded ground water of unknown origin exists in 64 basins.

No intrusion is apparent in 34 basins.

No data is available for 137 basins.

Conclusions

Sea-water intrusion threatens local ground water supplies in several large, significant coastal areas. In Santa Clara Valley (San Francisco Bay area) and the Coastal Plain (Los Angeles and Orange Counties), comprehensive corrective measures are being successfully applied. In Pajaro and Salinas Valleys (Monterey Bay area) and the Oxnard Plain (Ventura County), only minor corrective steps are being taken.

Establishing a periodic statewide monitoring system to keep track of intrusion is essential to alert the appropriate agencies to the need for remedial action. Monitoring includes water quality sampling and ground water level measurement.

The follow conclusions have been derived from this investigation:

Monitoring in known areas of intrusion will define the location, extent, and rate of intrusion.

Monitoring may help determine whether intrusion has actually occurred in questionable areas, such as suspected areas of intrusion, areas of degraded ground water of unknown origin, and areas having no apparent intrusion.

Monitoring and further geologic studies of basins where no data are presently available will help define the potential for intrusion.

When local agencies determine that intrusion is occurring, they have two courses to follow. They can (a) investigate to more nearly define the rate and extent of intrusion before choosing control methods, or (b) if they have enough information, they can begin work to alleviate the problem.

Recommendations

The points below are set forth as a basis for a statewide sea-water intrusion monitoring program that can be achieved cooperatively by local, state, and federal agencies.

Known areas of intrusion should be monitored at least every one to two years.

Questionable areas of high chlorides should be monitored at least every three years.

Areas for which no data is available should be surveyed at five-year periods.

Local agencies are encouraged to publish results of monitoring as soon as possible upon completion.

Agencies are encouraged to consider various methods of control, including water conservation, limitation of new ground water extractions, use of reclaimed waste water to recharge ground water bodies, and several physical on-site techniques, such as injection wells.

CHAPTER II. STATUS OF SEA-WATER INTRUSION

Comparison of Conditions, 1953-1955 and 1970-1971

The results of the 1953-1955 and the 1970-1971 investigations into the status of sea-water intrusion differ in the number of classifications used to identify the extent of intrusion. In the earlier survey, basins having suspected intrusion and basins containing high chloride water were grouped together. In the 1970-1971 survey, these two classes of basins are listed separately. Data from the more recent investigation are also shown in a new classification, "Areas For Which No Information Is Available, 1970-1971", which was set up specifically to cover those basins for which information on intrusion was obtained from the 1953-1955 survey but not from the 1970-1971 survey. Continuation of the additional classifications could be most useful when future statewide programs of sea-water intrusion sampling are undertaken.

Classifications Used in 1953-1955 Survey	Classifications Used in 1970-1971 Survey
1. Known intrusion	1. Known intrusion
2. Suspected intrusion and over 100 ppm chlorides	2. Suspected intrusion
	3. Chlorides exceed 100 ppm
3. No apparent intrusion	4. No apparent intrusion
4. Status of intrusion unknown	5. Status of intrusion unknown
	6. No information available, 1970-71

Areas of Known Sea-Water Intrusion

The 1970-1971 survey identifies 14 basins that have been intruded by sea water (Table 1). The 1953-1955 survey listed nine ground water basins that had been intruded by sea water. The five additional basins are all small alluvium-filled valleys where intrusion appears to be confined to the immediate coastal portion.

The nine basins defined in 1953-1955 are classified on the basis of intensity of sea-water intrusion: most serious, critical, and continuing.

Most Serious Intrusion. Three basins were identified in the 1953-1955 survey as having a most serious intrusion problem: Santa Clara Valley (Basin 105, San Francisco Bay Area); West Coast Basin (Basin 234, Los Angeles County); and East Coastal Plain Pressure Area (Basin 235, Orange County). Encroachment of sea water in these three basins has since been partially arrested by local agencies that carried out ground water management plans developed cooperatively by the agencies and the Department of Water Resources. These efforts combined several procedures to slow the rate of intrusion: in Northern California, water taken from the South Bay Aqueduct of the State Water Project was spread and ground water pumping was reduced; and in Southern California, Colorado River water was used for injection, ground water pumping was reduced, and

local and imported water was used for artificial recharge. Continuation and some expansion of this work will eventually stabilize sea-water intrusion in all three basins. Figures 5A-5D and 6 show sea-water encroachment in Santa Clara Valley in Alameda, Santa Clara, and San Mateo Counties since 1926, and Figure 10 shows the status of intrusion and degradation in the Coastal Plain of Los Angeles and Orange Counties since 1955.

Critical Intrusion. Three ground water basins were identified in the 1953-1955 survey as having a critical sea-water intrusion problem. These were Pajaro Valley (Basin 147, Santa Cruz and Monterey Counties); Salinas Valley Pressure Area (Basin 149, Monterey County); and Santa Clara River Valley-Oxnard Plain Basin (Basin 218, Ventura County). Sea-water encroachment has continued unabated in these basins since the 1953-1955 survey. Local agencies are well aware of the problem and over the years have conducted studies both independently and in cooperation with the Department of Water Resources and the Water Resources Division of the U. S. Geological Survey. However, as of 1973, no comprehensive attempt to restrain sea-water intrusion by reducing ground water pumping, constructing barriers, or importing fresh water supplies had been undertaken in these basins. Encroachment of sea water in these basins since 1954 is shown in Figures 7, 8, and 9.

Continuing Intrusion. Three ground water basins were identified in the 1953-1955 survey as having a continuing sea-water intrusion problem. These were Petaluma Valley (Basin 87, Marin and Sonoma Counties); Napa-Sonoma Valley (Basin 88, Napa and Sonoma Counties); and San Luis Rey Valley-Mission Basin (Basin 243, San Diego County). The current magnitude of sea-water intrusion in these basins is not clearly defined, but the situation can become acute if ground water extractions are increased. Importation of water into the northern San Francisco Bay Area counties by the U. S. Bureau of Reclamation's Putah South Canal and the North Bay Aqueduct of the State Water Project have helped meet local water needs. When ground water pumping in the coastal portion of San Luis Rey Valley is reduced, intrusion there tends to stabilize. Figure 3 shows the status of intrusion in Petaluma Valley and Napa-Sonoma Valley since 1954.

Areas of Suspected Sea-Water Intrusion

The 1970-1971 survey identifies 14 areas of suspected intrusion (Table 2). All are small alluviated basins, except for two relatively large areas: Suisun-Fairfield Valley (Basin 92, Solano County); and Sacramento-San Joaquin Delta (Basin 93, Sacramento, San Joaquin, and Contra Costa Counties).

Although currently available information indicates that sea water is apparently the most likely source of ground water degradation in these basins, future sampling and detailed studies may show that such degradation is due to some man-made or natural activity. The suspected encroachment of sea water in Suisun-Fairfield Valley since 1954 is shown in Figure 4.

Areas Where Chlorides Exceed 100 ppm

The 1970-1971 survey identifies 64 basins as having chlorides exceeding 100 parts per million (ppm) (Table 3). In this report, a chloride concentration of 100 ppm is used as an arbitrary designator that signals the presence of poor quality water. This early indicator sometimes is detected soon enough for remedial action to be taken or some kind of monitoring program to be started.

Eight of the 64 basins are relatively large areas. They include Eureka Plain (Basin 12, Humboldt County); Half Moon Bay Terrace (Basin 118, San Mateo County); Monterey Area (Basin 150,

Monterey County); Arroyo Grande (Basin 176, San Luis Obispo County); Santa Ynez Valley-Lompoc Plain (Basins 180 and 181), Santa Barbara Basin (Basin 213), and Montecito Area (Basin 214), all in Santa Barbara County; and West Coastal Plain-North (Basin 233, Los Angeles County). The remaining 56 basins are all small alluviated valleys.

A positive determination that sea water, not some other source of high chlorides, is degrading the quality of water in these basins cannot be made on the basis of information presently available. To make such a finding, additional data on water quality, water levels, hydraulic gradients, ground water extractions, and subsurface geology must be collected and evaluated.

Areas of No Apparent Sea-Water Intrusion

The 1970-1971 survey identifies 34 basins as having no apparent sea-water intrusion (Table 4). All are small alluviated valleys and terraces, except for five relatively large areas: Smith River Plain (Basin 1, Del Norte County); Santa Maria River Valley (Basin 177, San Luis Obispo and Santa Barbara Counties); Goleta Basin (Basin 210, Santa Barbara County); Carpinteria Basin (Basin 215, Santa Barbara County); and Mound Basin (Basin 217, Ventura County).

As far as can be determined, ground water in the coastal portions of these basins has not been degraded by sea water. However, intrusion can occur if increased ground water extractions depress water levels below sea level and reverse the normal seaward hydraulic gradient.

Areas Where the Status of Sea-Water Intrusion is Unknown

The 1970-1971 survey identifies 114 basins for which the status of sea-water intrusion is unknown (Table 5). All are small alluviated valleys and terraces.

Little or no development of ground water has occurred in most of these basins since the 1953-1955 survey. Basic data in the form of water quality analyses, water level measurements, ground water extractions, and subsurface geology are essentially unavailable. If ground water extractions are increased, intrusion could occur.

Areas for Which No Information is Available, 1970-1971

The 1970-1971 survey identifies 23 basins as areas for which no sea-water intrusion information is available (Table 6). All are relatively small valleys. However, there is historic information on some of these basins, as shown in the 1953-1955 survey in which about half the 23 basins were found to contain ground water with chlorides exceeding 100 ppm or were suspected of having been intruded by ocean water.

Table 1. AREAS OF KNOWN SEA-WATER INTRUSION, 1970-1971

Basin No.	Basin Name	County	Status, 1953-1954 Survey
13	Eel River Valley	Humboldt	Suspected sea-water intrusion
87	Petaluma Valley	Sonoma and Marin	Known sea-water intrusion
88	Napa-Sonoma Valley	Sonoma, Napa, and Solano	Known sea-water intrusion
105	Santa Clara Valley	Contra Costa, Alameda, Santa Clara and San Mateo	Known sea-water intrusion
147	Pajaro Valley	Santa Cruz and Monterey	Known sea-water intrusion
148	Elkhorn Slough Area	Santa Cruz and Monterey	Status unknown
149	Salinas Valley Pressure Area	Monterey	Known sea-water intrusion
171	Morro Basin	San Luis Obispo	Chlorides exceed 100 ppm
172	Chorro Basin	San Luis Obispo	Chlorides exceed 100 ppm
173	Los Osos Basin	San Luis Obispo	No apparent sea-water intrusion
218	Oxnard Plain Basin	Ventura	Known sea-water intrusion
234	West Coast Basin	Los Angeles	Known sea-water intrusion
235	East Coastal Plain Pressure Area	Orange	Known sea-water intrusion
243	San Luis Rey Valley-Mission Basin	San Diego	Known sea-water intrusion

Table 2. AREAS OF SUSPECTED SEA-WATER INTRUSION, 1970-1971

Basin No.	Basin Name	County	Status, 1953-1954 Survey
57	Russian River Basin	Sonoma	Suspected sea-water intrusion
70	Drakes Estero Basin	Marin	No apparent sea-water intrusion
76	Bolinas Lagoon Basin	Marin	No apparent sea-water intrusion
77	Frank Creek Basin	Marin	Suspected sea-water intrusion
81	Richardson Bay Basin	Marin	No apparent sea-water intrusion
82	Ross Valley Basin	Marin	No apparent sea-water intrusion
83	San Rafael Basin	Marin	Chlorides exceed 100 ppm
92	Suisun-Fairfield Valley	Solano	Suspected sea-water intrusion
93	Sacramento-San Joaquin Delta	Solano, Sacramento, San Joaquin, and Contra Costa	Chlorides exceed 100 ppm
119	Tunitas Creek Basin	San Mateo	Status unknown
151	Carmel Valley	Monterey	No apparent sea-water intrusion
154	Big Sur River Basin	Monterey	No apparent sea-water intrusion
162	Santa Rosa Creek Basin	San Luis Obispo	No apparent sea-water intrusion
255	San Diego River-Mission Valley Basin	San Diego	Chlorides exceed 100 ppm

Table 3. AREAS WHERE CHLORIDES EXCEED 100 PPM, 1970-1971

Basin		County	Status, 1953-1955 Survey
No.	Name		
4	Lower Klamath River Basin	Del Norte	No apparent sea-water intrusion
6	Redwood Creek Basin	Humboldt	Suspected sea-water intrusion
11	Mad River Valley and Plain	Humboldt	Suspected sea-water intrusion
12	Eureka Plain	Humboldt	Suspected sea-water intrusion
62	Estero de San Antonio Basin	Marin	Status unknown
67	Point Reyes Sand Dunes Area	Marin	No apparent sea-water intrusion
69	Point Reyes Basin	Marin	Status unknown
97	Big Bull Basin	Contra Costa	Status unknown
99	Canada del Cierbo Basin	Contra Costa	Status unknown
100	Oleum Basin	Contra Costa	Status unknown
102	Refugio Basin	Contra Costa	Status unknown
110	Market Street Basin	San Francisco	Chlorides exceed 100 ppm
118	Half Moon Bay Terrace	San Mateo	Chlorides exceed 100 ppm
150	Monterey Area	Monterey	Chlorides exceed 100 ppm
158	Arroyo del Corral Basin	San Luis Obispo	Chlorides exceed 100 ppm
159	Arroyo Laguna Basin	San Luis Obispo	Status unknown
163	Villa Basin	San Luis Obispo	Chlorides exceed 100 ppm
165	Cayucos Point Basin	San Luis Obispo	Chlorides exceed 100 ppm
166	Cayucos Basin	San Luis Obispo	Chlorides exceed 100 ppm
167	Little Cayucos Basin	San Luis Obispo	Chlorides exceed 100 ppm
170	Toro Basin	San Luis Obispo	Chlorides exceed 100 ppm
174	San Luis Obispo Basin	San Luis Obispo	No apparent sea-water intrusion
175	Pismo Basin	San Luis Obispo	Chlorides exceed 100 ppm
176	Arroyo Grande Basin	San Luis Obispo	No apparent sea-water intrusion
178	Schumann Canyon Basin	Santa Barbara	Chlorides exceed 100 ppm
179	San Antonio Creek Valley	Santa Barbara	Status unknown
180	Santa Ynez River Valley	Santa Barbara	Suspected sea-water intrusion
181	Lompoc Terrace (formerly Bear Creek Basin)	Santa Barbara	Status unknown
184	Jalama Basin	Santa Barbara	Status unknown
185	Cojo Basin	Santa Barbara	Chlorides exceed 100 ppm
195	Gaviota Basin	Santa Barbara	Chlorides exceed 100 ppm
198	Arroyo Hondo Basin	Santa Barbara	No apparent sea-water intrusion
200	Tajiguas Basin	Santa Barbara	Chlorides exceed 100 ppm
201	Canada del Refugio Basin	Santa Barbara	Chlorides exceed 100 ppm
202	Canada del Corral Basin	Santa Barbara	Chlorides exceed 100 ppm
208	Bell Canyon Basin	Santa Barbara	Chlorides exceed 100 ppm

Table 3. AREAS WHERE CHLORIDES EXCEED 100 PPM, 1970-1971 (Continued)

Basin No.	Basin Name	County	Status, 1953-1955 Survey
209	Campbell Creek Basin	Santa Barbara	Chlorides exceed 100 ppm
213	Santa Barbara Basin	Santa Barbara	No apparent sea-water intrusion
214	Montecito Area (formerly Oriegas Basin)	Santa Barbara	Status unknown
216	Ventura River Valley	Ventura	Suspected sea-water intrusion
219	Big Sycamore Basin	Ventura	Chlorides exceed 100 ppm
222	Trancas Basin	Los Angeles	No apparent sea-water intrusion
223	Zuma Canyon Basin	Los Angeles	Chlorides exceed 100 ppm
228	Malibu Basin	Los Angeles	Chlorides exceed 100 ppm
229	Las Flores Basin	Los Angeles	Chlorides exceed 100 ppm
230	Topanga Basin	Los Angeles	No apparent sea-water intrusion
233	West Coastal Plain-North	Los Angeles	Chlorides exceed 100 ppm
238	Aliso Basin	Orange	Chlorides exceed 100 ppm
239	San Juan Valley	Orange	Chlorides exceed 100 ppm
240	San Mateo Valley	San Diego	No apparent sea-water intrusion
242	Santa Margarita Valley Coastal Basin	San Diego	Suspected sea-water intrusion
244	Loma Alta Basin	San Diego	Chlorides exceed 100 ppm
245	Buena Vista Creek Basin	San Diego	Chlorides exceed 100 ppm
246	Agua Hedionda Basin	San Diego	Chlorides exceed 100 ppm
247	Encinas Basin	San Diego	Chlorides exceed 100 ppm
248	San Marcos Basin	San Diego	Chlorides exceed 100 ppm
249	San Elijo Basin	San Diego	Chlorides exceed 100 ppm
250	San Dieguito Valley	San Diego	Suspected sea-water intrusion
251	Soledad Basin	San Diego	Chlorides exceed 100 ppm
253	Rose Canyon Basin	San Diego	Chlorides exceed 100 ppm
256	Las Chollas Basin	San Diego	Chlorides exceed 100 ppm
260	Sweetwater Valley	San Diego	Chlorides exceed 100 ppm
261	Otay Valley	San Diego	Chlorides exceed 100 ppm
262	Tia Juana Basin	San Diego	Suspected sea-water intrusion

Table 4. AREAS OF NO APPARENT SEA-WATER INTRUSION, 1970-1971

Basin No.	Basin Name	County	Status, 1953-1955 Survey
1	Smith River Plain	Del Norte	No apparent sea-water intrusion
22	Cottoneva Creek Basin	Mendocino	No apparent sea-water intrusion
49	Garcia River Basin	Mendocino	No apparent sea-water intrusion
58	Scotty Creek Basin	Sonoma	Status unknown
59	Salmon Creek Valley Basin	Sonoma	Status unknown
60	Bodega Bay Basin	Sonoma	Chlorides exceed 100 ppm
63	Sand Point Area	Marin	Status unknown
64	Walker Creek Basin	Marin	No apparent sea-water intrusion
65	Tomales Bay Basin	Marin	No apparent sea-water intrusion
101	Rodeo Basin	Contra Costa	Status unknown
112	Merced Valley Basin	San Francisco	No apparent sea-water intrusion
114	Calera Basin	San Mateo	No apparent sea-water intrusion
115	San Pedro Basin	San Mateo	No apparent sea-water intrusion
122	Pescadero Basin	San Mateo	No apparent sea-water intrusion
125	Ano Nuevo Terrace	San Mateo	Status unknown
156	San Carpoforo Basin	San Luis Obispo	Status unknown
157	Arroyo de la Cruz Basin	San Luis Obispo	No apparent sea-water intrusion
160	Pico Creek Basin	San Luis Obispo	No apparent sea-water intrusion
161	San Simeon Basin	San Luis Obispo	No apparent sea-water intrusion
168	Old Creek Basin	San Luis Obispo	No apparent sea-water intrusion
169	Willow Creek Basin	San Luis Obispo	Status unknown
177	Santa Maria River Valley	San Luis Obispo and Santa Barbara	No apparent sea-water intrusion
189	San Augustin Basin	Santa Barbara	No apparent sea-water intrusion
203	Capitan Basin	Santa Barbara	No apparent sea-water intrusion
204	Las Varas Basin	Santa Barbara	Chlorides exceed 100 ppm
205	Dos Pueblos Basin	Santa Barbara	No apparent sea-water intrusion
207	Tecolote Basin	Santa Barbara	No apparent sea-water intrusion
210	Goleta Basin	Santa Barbara	No apparent sea-water intrusion
215	Carpinteria Basin	Santa Barbara	Suspected sea-water intrusion
217	Mound Basin	Ventura	No apparent sea-water intrusion
220	Little Sycamore Basin	Ventura	No apparent sea-water intrusion
221	Arroyo Sequit Basin	Los Angeles	No apparent sea-water intrusion
236	Sand Canyon Basin	Orange	No apparent sea-water intrusion
241	San Onofre Valley	San Diego	Chlorides exceed 100 ppm

Table 5. AREAS WHERE THE STATUS OF SEA-WATER INTRUSION IS UNKNOWN, 1970-1971

Basin No.	Basin Name	County	Status, 1953-1955 Survey
2	Wilson Creek Basin	Del Norte	Status unknown
3	Cedar Mill Basin	Del Norte	Status unknown
5	Prairie Creek Area	Humboldt	Status unknown
8	Maple Creek Basin	Humboldt	Status unknown
9	Little River Basin	Humboldt	Status unknown
10	Dows Prairie Area	Humboldt	Status unknown
14	Fleener Creek Basin	Humboldt	Status unknown
15	Bear River Basin	Humboldt	Status unknown
16	Singley Creek Terrace	Humboldt	Status unknown
17	Davis Creek Terrace	Humboldt	Status unknown
18	Mattole River Basin	Humboldt	Status unknown
19	Big Flat Creek Basin	Humboldt	Status unknown
20	Jackass Creek Basin	Mendocino	Status unknown
21	Usal Creek Basin	Mendocino	Status unknown
23	Hardy Creek Basin	Mendocino	Status unknown
24	Juan Creek Basin	Mendocino	Status unknown
25	Howard Creek Basin	Mendocino	Status unknown
26	De Haven Creek Basin	Mendocino	Status unknown
27	Wages Creek Basin	Mendocino	Status unknown
28	Abalobadiah Creek Basin	Mendocino	Status unknown
29	Seaside Creek Basin	Mendocino	Status unknown
30	Ten Mile River Basin	Mendocino	Status unknown
31	Little Valley Area	Mendocino	Status unknown
32	Mill Creek Basin	Mendocino	Status unknown
33	Pudding Creek Basin	Mendocino	Status unknown
34	Noyo River Basin	Mendocino	Status unknown
35	Hare River Basin	Mendocino	Status unknown
36	Jug Handle Creek Basin	Mendocino	Status unknown
37	Caspar Creek Basin	Mendocino	Status unknown
38	Russian Gulch Basin	Mendocino	Status unknown
39	Big River Basin	Mendocino	Status unknown
40	Little River Basin	Mendocino	Status unknown
41	Albion River Basin	Mendocino	Status unknown
42	Salmon Creek Basin	Mendocino	Status unknown
43	Navarro River Basin	Mendocino	Status unknown

Table 5. AREAS WHERE THE STATUS OF SEA-WATER INTRUSION IS UNKNOWN, 1970-1971 (Continued)

Basin No.	Basin Name	County	Status, 1953-1955 Survey
44	Greenwood Creek Basin	Mendocino	Status unknown
45	Elk Creek Basin	Mendocino	Status unknown
46	Alder Creek Basin	Mendocino	Status unknown
47	Staramella Ranch Basin	Mendocino	Status unknown
48	Brush Creek Basin	Mendocino	Status unknown
50	Point Arena Creek Basin	Mendocino	Status unknown
51	Mate Creek Basin	Mendocino	Status unknown
52	Ross Creek Basin	Mendocino	Status unknown
53	Gallaway Creek Basin	Mendocino	Status unknown
54	Schooner Gulch Basin	Mendocino	Status unknown
55	Gualala River Basin	Mendocino and Sonoma	Status unknown
56	Russian Gulch Basin	Sonoma	Status unknown
61	Estero Americano Basin	Sonoma, Marin	Status unknown
66	Kehoe Creek Basin	Marin	Status unknown
68	Drakes Bay Basin	Marin	Status unknown
71	Estero de Limantour Basin	Marin	Status unknown
72	Glenbrook Creek Basin	Marin	Status unknown
73	Muddy Hollow Basin	Marin	Status unknown
75	Bear Valley Basin	Marin	Status unknown
78	Elk Valley Basin	Marin	Status unknown
80	Horseshoe Bay Basin	Marin	Status unknown
84	Marin Island Basin	Marin	Status unknown
91	Sulphur Springs Basin	Solano	Status unknown
95	Arroyo del Hambre Basin	Contra Costa	Status unknown
96	Little Bull Basin	Contra Costa	Status unknown
98	Crockett Basin	Contra Costa	Status unknown
103	Pinole Basin	Contra Costa	Status unknown
104	Sobrante Basin	Contra Costa	Status unknown
106	Guadalupe Basin	San Mateo	Status unknown
107	Visitacion Basin	San Francisco	Status unknown
108	Potrero Basin	San Francisco	Status unknown
109	Islais Basin	San Francisco	Status unknown
111	Fort Mason Basin	San Francisco	Status unknown
116	Montara Terrace	San Mateo	Status unknown
117	Montara Point Basin	San Mateo	Status unknown

Table 5. AREAS WHERE THE STATUS OF SEA-WATER INTRUSION IS UNKNOWN, 1970-1971 (Continued)

Basin		County	Status, 1953-1955 Survey
No.	Name		
121	Pomponio Basin	San Mateo	Status unknown
123	Los Frijoles Basin	San Mateo	Status unknown
124	White House Creek Basin	San Mateo	Status unknown
126	Waddell Basin	Santa Cruz	Status unknown
128	Molino Creek Basin	Santa Cruz	Status unknown
129	Davenport Landing	Santa Cruz	Status unknown
130	San Vicente Creek Basin	Santa Cruz	Status unknown
131	Liddell Creek Basin	Santa Cruz	Status unknown
132	Respini Creek Basin	Santa Cruz	Status unknown
133	Laguna Creek Basin	Santa Cruz	Status unknown
134	Majors Creek Basin	Santa Cruz	Status unknown
135	Baldwin Creek Basin	Santa Cruz	Status unknown
136	Needle Rock Basin	Santa Cruz	Status unknown
137	Sandy Flat Basin	Santa Cruz	Status unknown
138	Meder Creek Basin	Santa Cruz	Status unknown
139	Terrace Basin	Santa Cruz	Status unknown
140	Moore Creek Basin	Santa Cruz	Status unknown
142	Arana Gulch Basin	Santa Cruz	Status unknown
143	Schwans Lagoon Basin	Santa Cruz	Status unknown
144	Doyle Basin	Santa Cruz	Status unknown
146	Valencia Creek Basin	Santa Cruz	Status unknown
153	Little Sur River Basin	Monterey	Status unknown
155	Sycamore Canyon Basin	Monterey	Status unknown
164	Geronimo Basin	San Luis Obispo	Status unknown
182	Spring Canyon Basin	Santa Barbara	Status unknown
183	Canada Honda Basin	Santa Barbara	Status unknown
186	Damsite Canyon Basin	Santa Barbara	Status unknown
187	Canada del Cojo Basin	Santa Barbara	Status unknown
188	Gato Basin	Santa Barbara	Status unknown
190	Agujas Basin	Santa Barbara	Status unknown
191	Bulito Basin	Santa Barbara	Status unknown
192	Canada de la Brea Basin	Santa Barbara	Status unknown
193	Canada de Santa Anita Basin	Santa Barbara	Status unknown
194	Alegria Basin	Santa Barbara	Status unknown
197	Canada San Onofre Basin	Santa Barbara	Status unknown

Table 5. AREAS WHERE THE STATUS OF SEA-WATER INTRUSION IS UNKNOWN, 1970-1971 (Continued)

Basin		County	Status, 1953-1955 Survey
No.	Name		
206	Eagle Canyon Basin	Santa Barbara	Status unknown
212	San Roque Basin	Santa Barbara	Status unknown
225	Escondido Canyon Basin	Los Angeles	Status unknown
227	Corral Canyon Basin	Los Angeles	Status unknown
231	Santa Ynez Canyon Basin	Los Angeles	Status unknown
232	Santa Monica Canyon Basin	Los Angeles	Status unknown
252	La Jolla Basin	San Diego	Status unknown
257	South Las Chollas Basin	San Diego	Status unknown
258	La Paleta Basin	San Diego	Status unknown

Table 6. AREAS FOR WHICH NO INFORMATION IS AVAILABLE, 1970-1971

Basin		County	Status, 1953-1955 Survey
No.	Name		
7	McDonald Creek Basin	Humboldt	No apparent sea-water intrusion
74	Laguna Ranch Basin	Marin	No apparent sea-water intrusion
79	Rodeo Lagoon Basin	Marin	No apparent sea-water intrusion
85	San Pedro Point Basin	Marin	No apparent sea-water intrusion
86	Novato Valley Basin	Marin	Suspected sea-water intrusion
89	Southampton Bay Basin	Solano	Suspected sea-water
90	Benicia Basin	Solano	Suspected sea-water intrusion
93A	Pittsburg Plain	Contra Costa	Status unknown
94	Clayton-Ygnacio Valley	Contra Costa	Status unknown
113	Sharp Park Terrace	San Mateo	Chlorides exceed 100 ppm
120	San Gregorio Creek Basin	San Mateo	Chlorides exceed 100 ppm
127	Scott Creek Basin	Santa Cruz	Suspected sea-water intrusion
141	San Lorenzo River Basin	Santa Cruz	No apparent sea-water intrusion
145	Soquel Valley	Santa Cruz	No apparent sea-water intrusion
152	San Jose Creek Basin	Monterey	No apparent sea-water intrusion
196	Cementario Basin	Santa Barbara	Chlorides exceed 100 ppm
199	Arroyo Quemado Basin	Santa Barbara	No apparent sea-water intrusion
211	Hope Basin	Santa Barbara	Chlorides exceed 100 ppm
224	Ramera Basin	Los Angeles	Chlorides exceed 100 ppm
226	Solstice Basin	Los Angeles	No apparent sea-water intrusion
237	Laguna Canyon Basin	Orange	Chlorides exceed 100 ppm
254	Tecolote Creek Basin	San Diego	Chlorides exceed 100 ppm
259	Paradise Basin	San Diego	Chlorides exceed 100 ppm

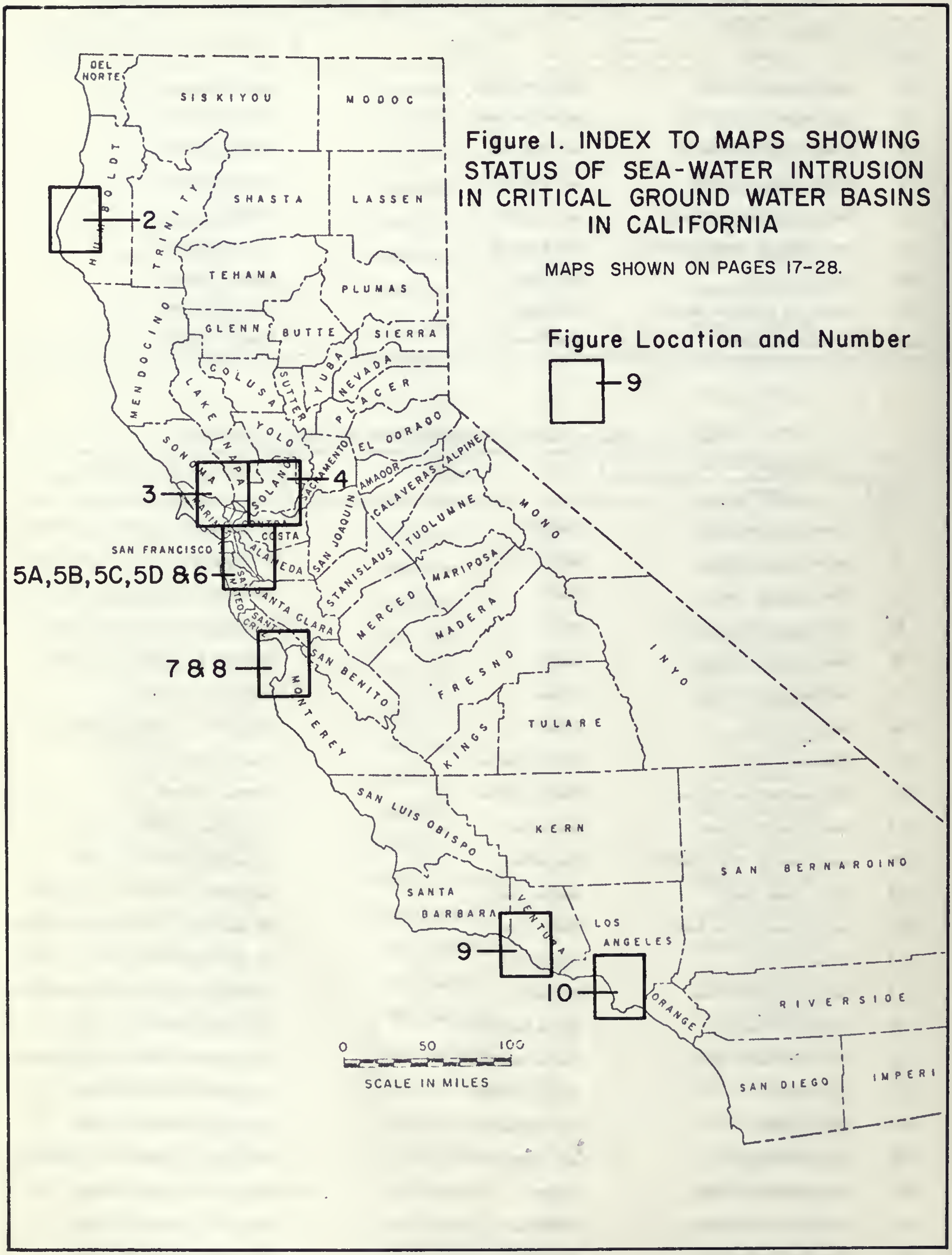


Figure I. INDEX TO MAPS SHOWING STATUS OF SEA-WATER INTRUSION IN CRITICAL GROUND WATER BASINS IN CALIFORNIA

MAPS SHOWN ON PAGES 17-28.

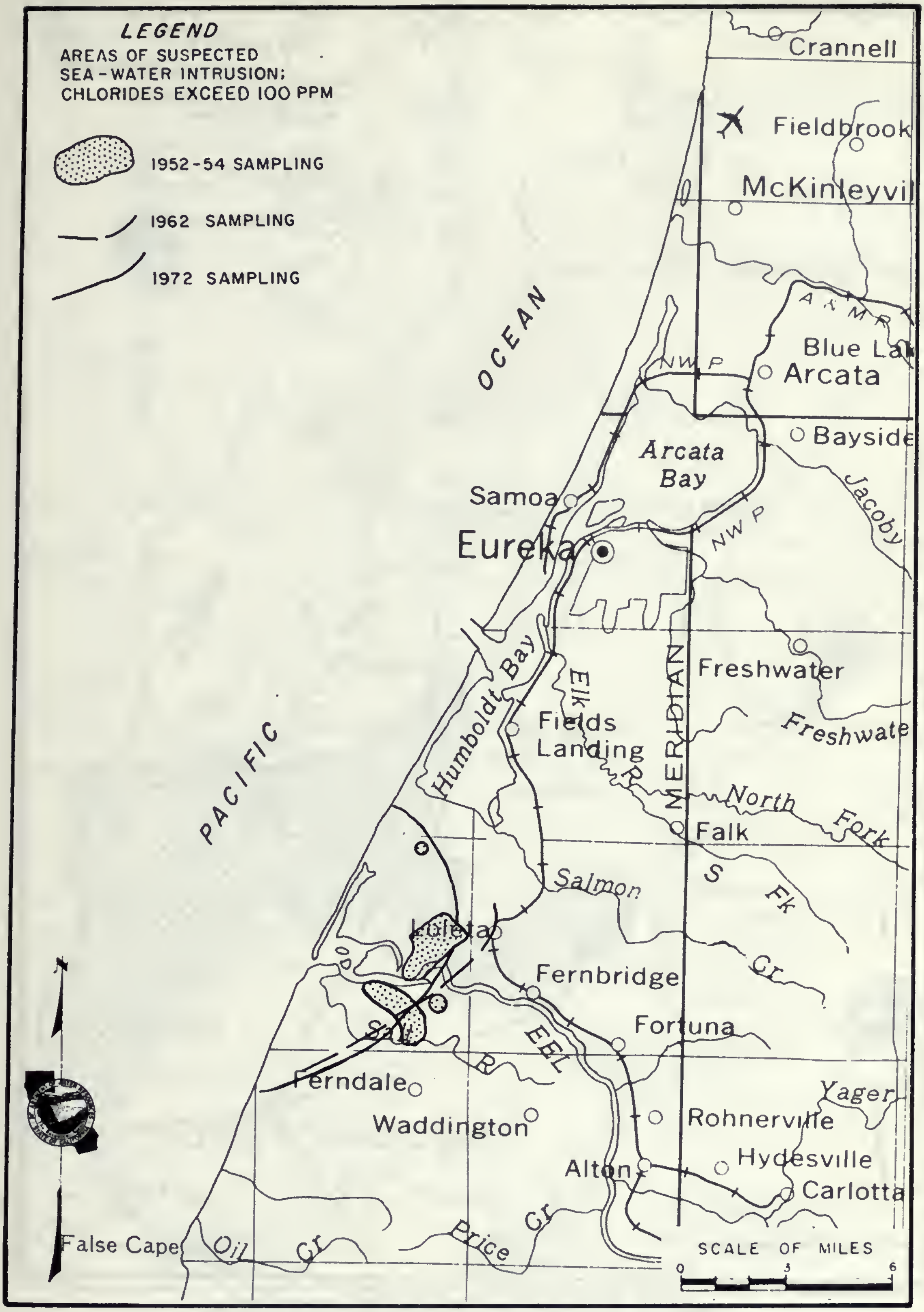


Figure 2. STATUS OF SEA-WATER INTRUSION
EEL RIVER VALLEY, HUMBOLDT COUNTY
1952-1954, 1962, AND 1970-1971

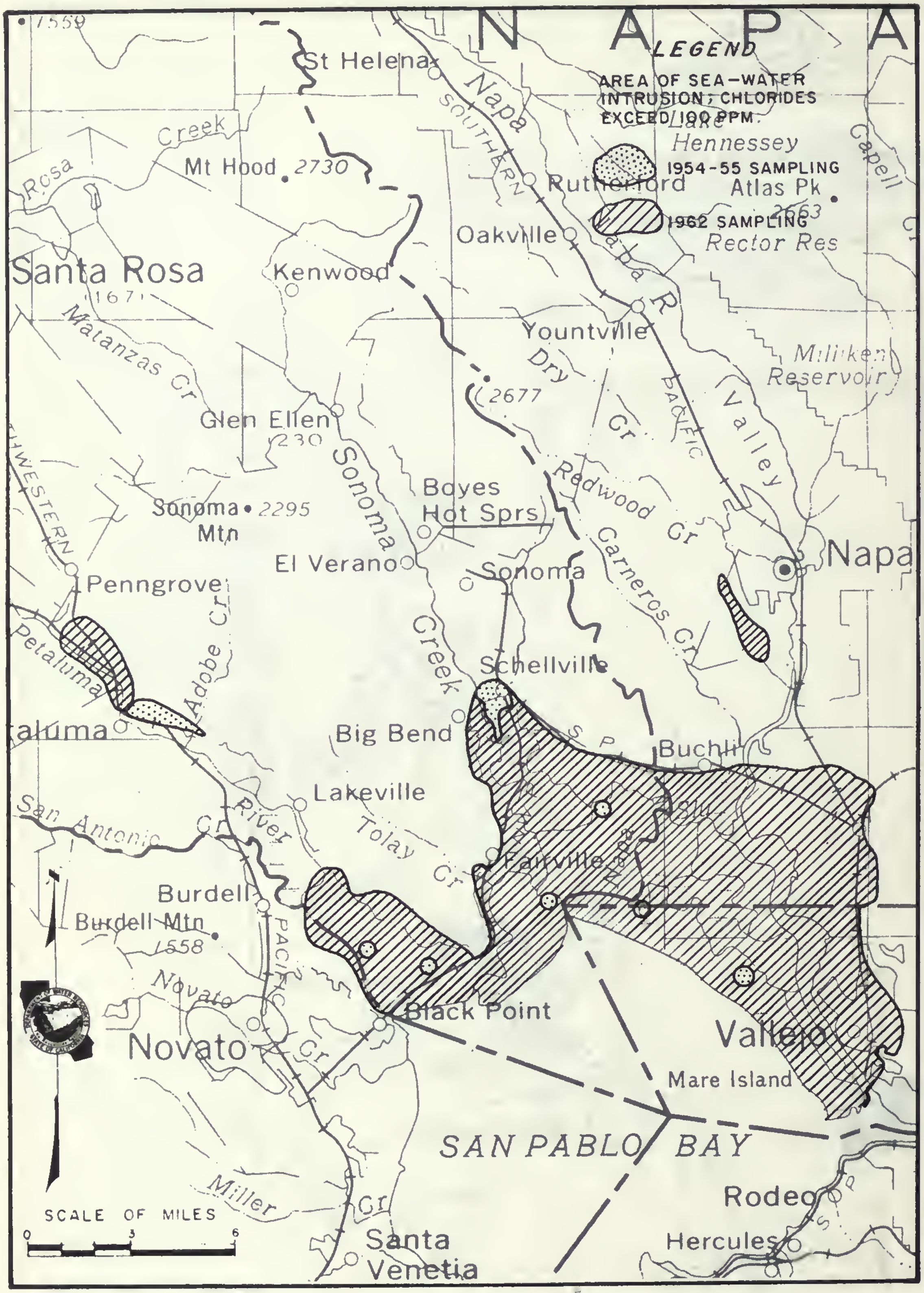


Figure 3. STATUS OF SEA-WATER INTRUSION, PETALUMA VALLEY AND NAPA-SONOMA VALLEY, MARIN, NAPA AND SONOMA COUNTIES 1954-1955, 1962, AND 1970-1971

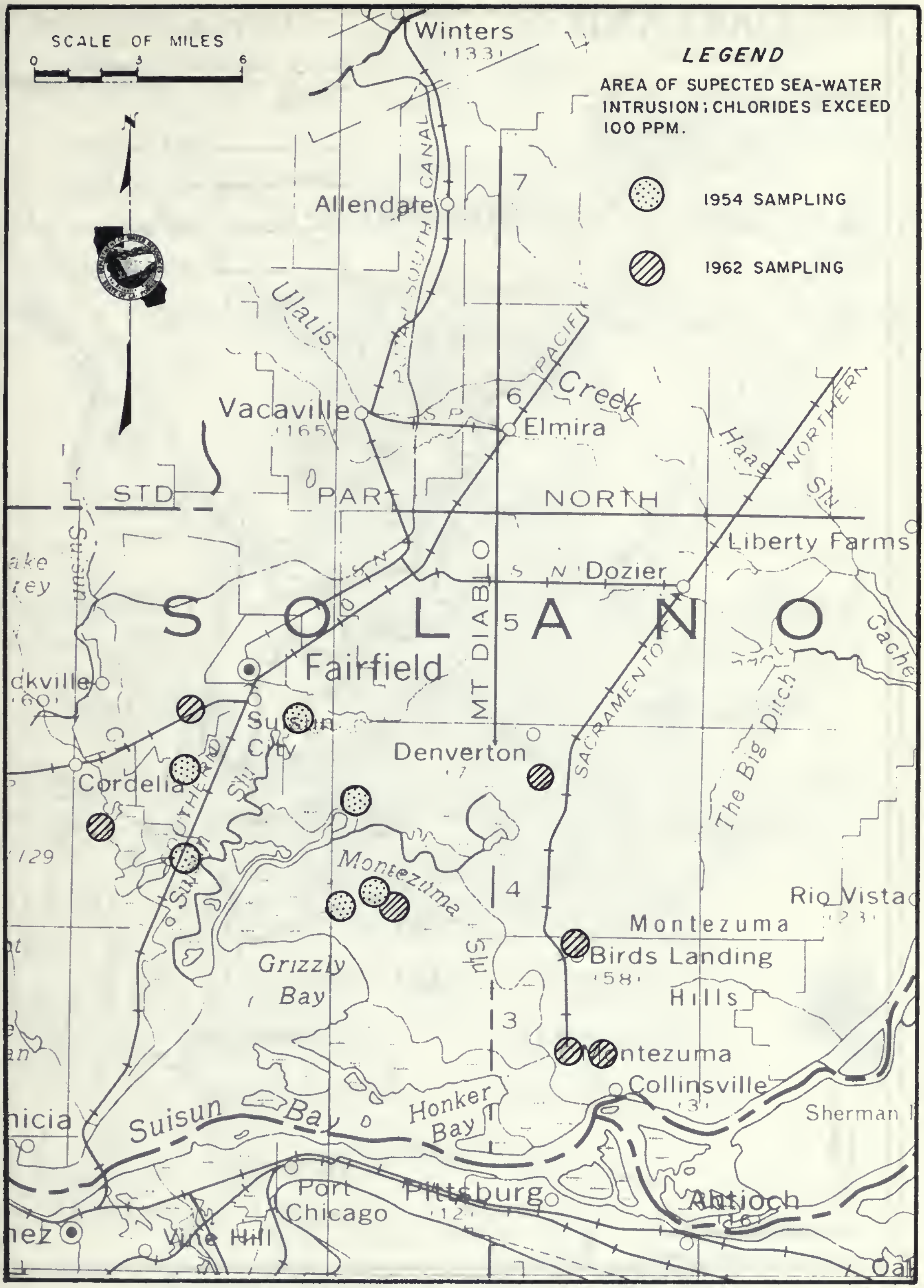


Figure 4. STATUS OF SUSPECTED SEA-WATER INTRUSION, SUISUN-FAIRFIELD VALLEY, SOLANO COUNTY 1954, 1962, AND 1970-1971

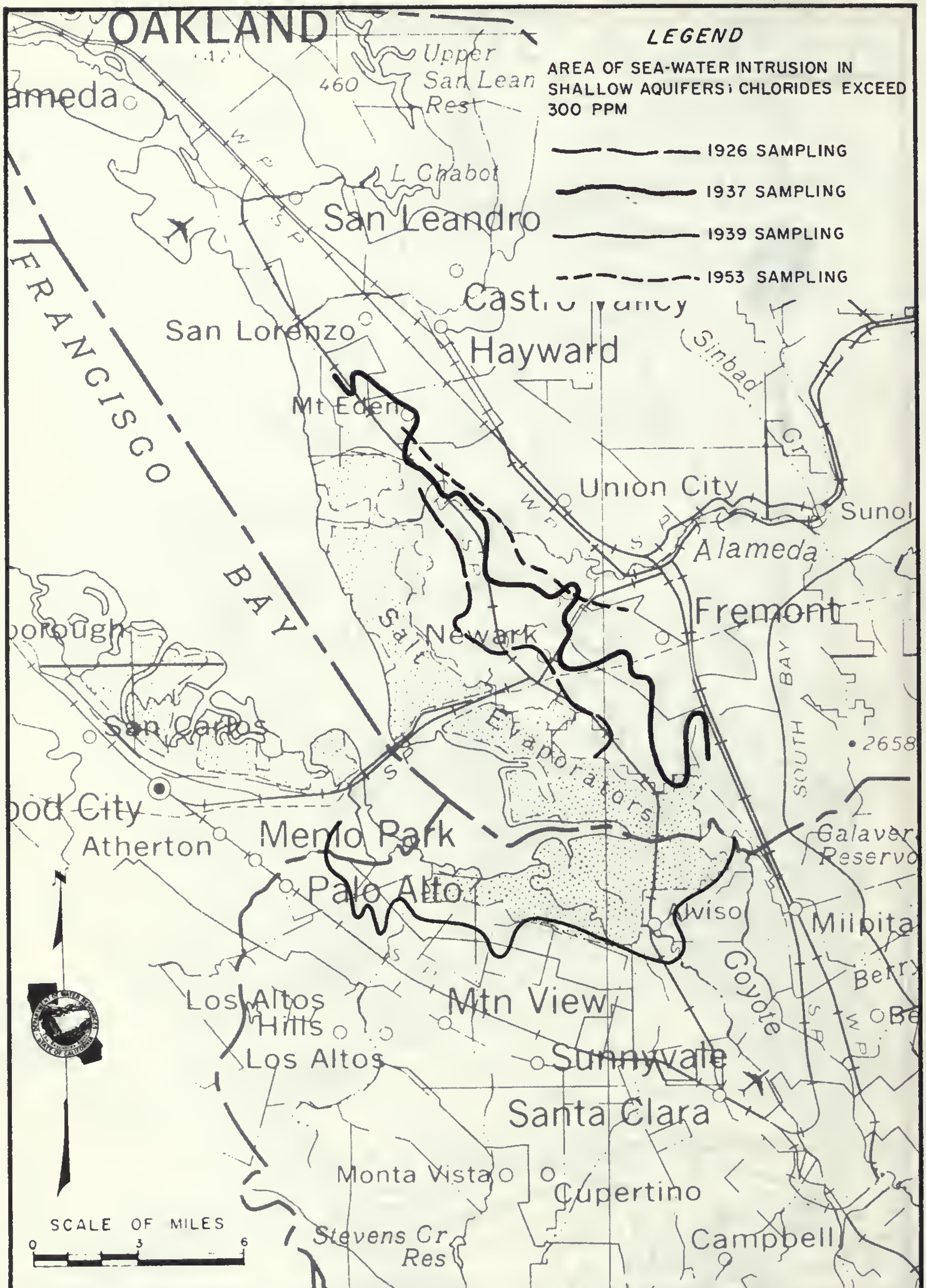


Figure 5A. STATUS OF SEA-WATER INTRUSION
UPPER AQUIFER, SANTA CLARA VALLEY
IN ALAMEDA, SANTA CLARA, AND SAN MATEO COUNTIES
1926, 1937, 1939 AND 1953

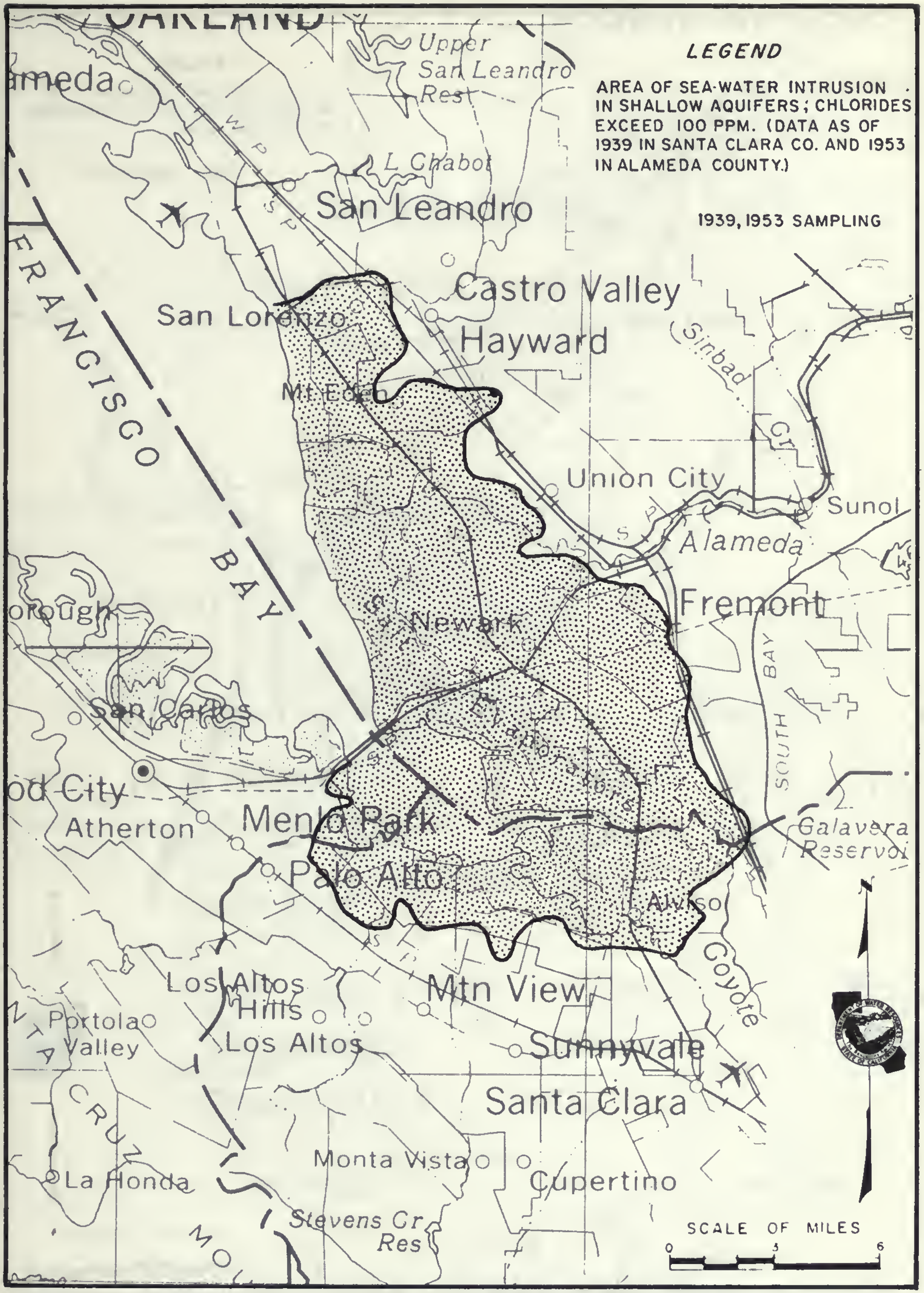


Figure 5B. STATUS OF SEA-WATER INTRUSION,
UPPER AQUIFER, SANTA CLARA VALLEY
IN ALAMEDA, SANTA CLARA, AND SAN MATEO COUNTIES
1939 AND 1953

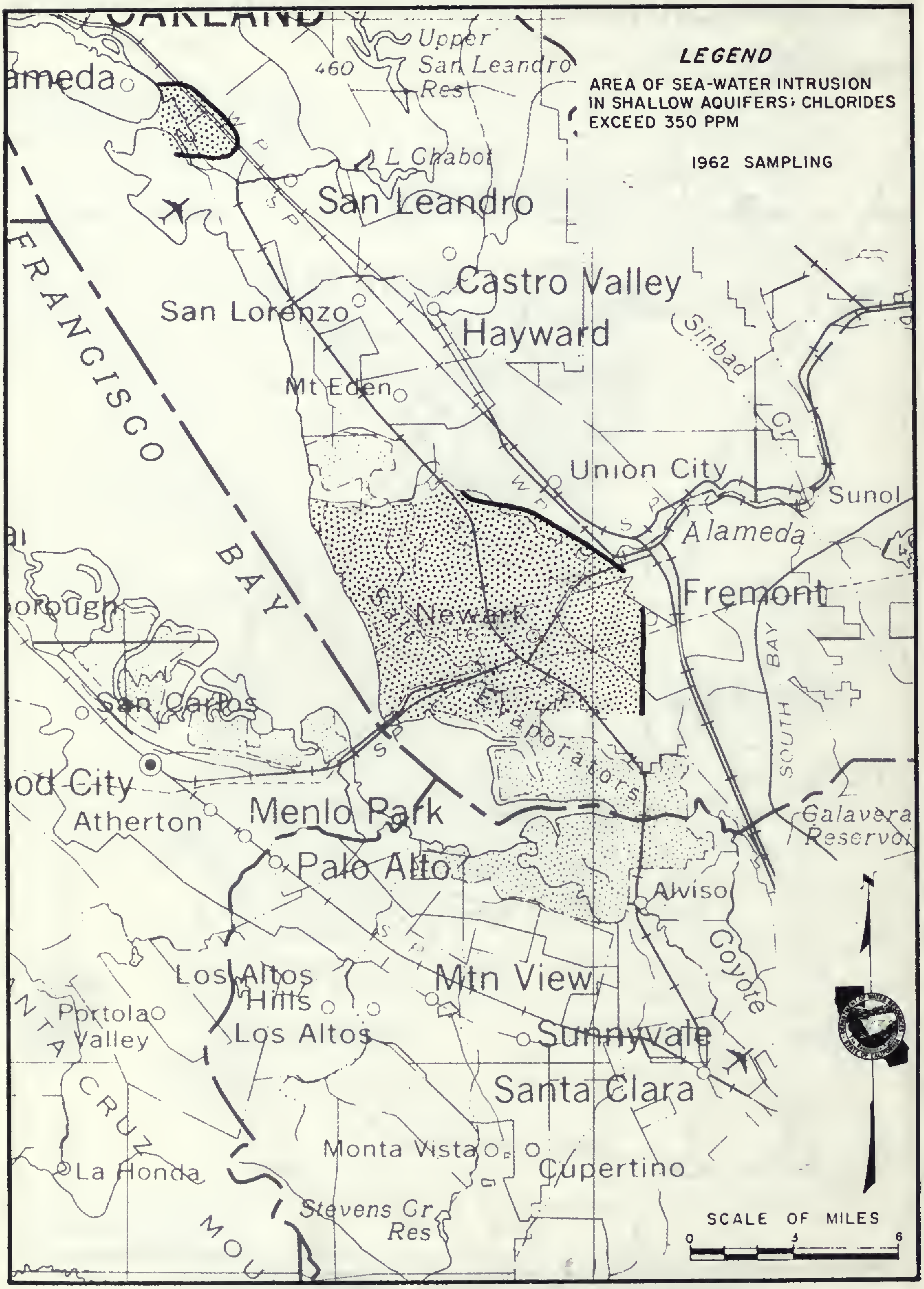


Figure 5C. STATUS OF SEA-WATER INTRUSION,
UPPER AQUIFER, SANTA CLARA VALLEY
IN ALAMEDA, SANTA CLARA, AND SAN MATEO COUNTIES
1962

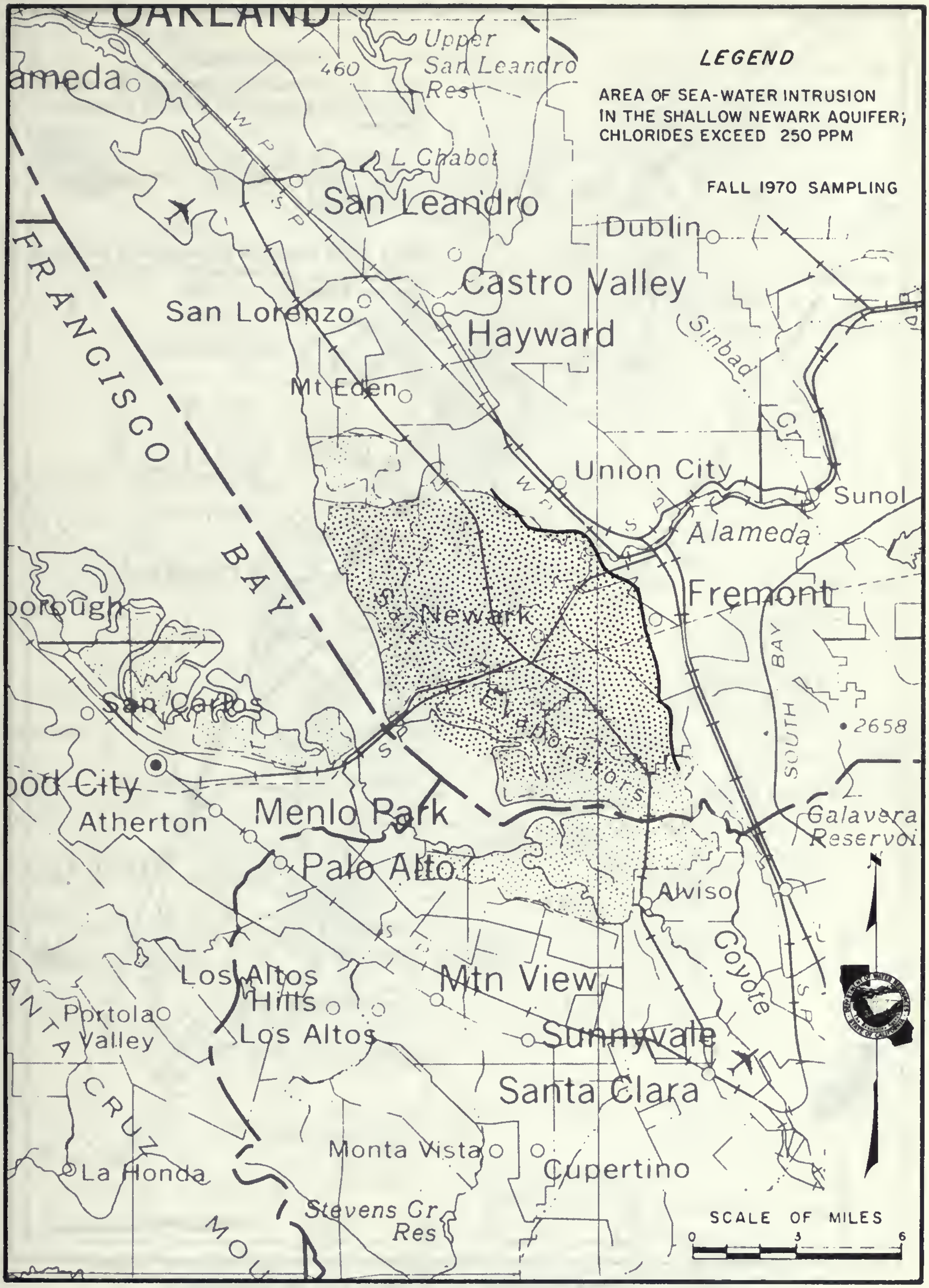


Figure 5D. STATUS OF SEA-WATER INTRUSION, UPPER AQUIFER, SANTA CLARA VALLEY IN ALAMEDA, SANTA CLARA, AND SAN MATEO COUNTIES FALL 1970

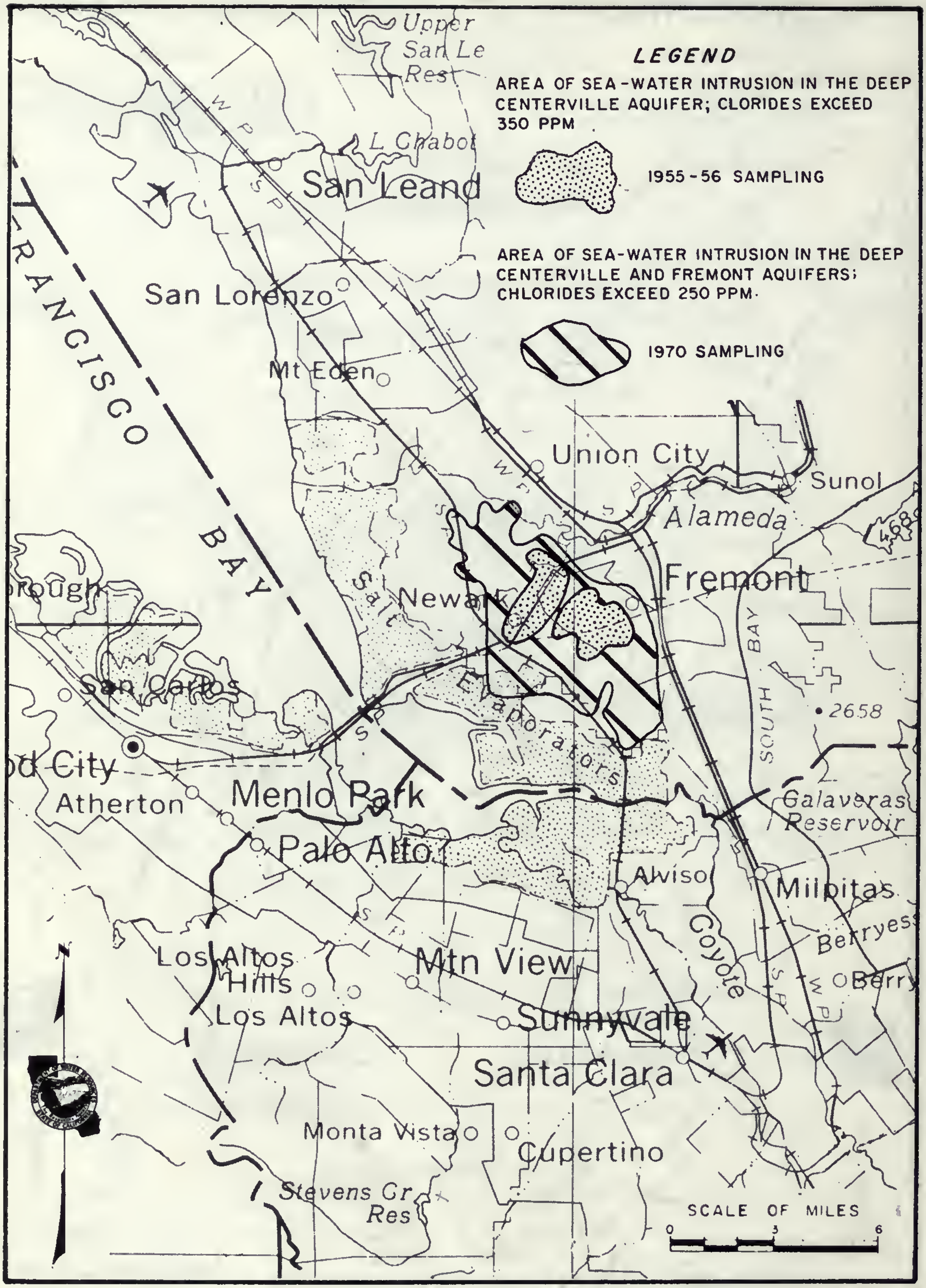


Figure 6. STATUS OF SEA-WATER INTRUSION, LOWER AQUIFER, SANTA CLARA VALLEY, ALAMEDA, SANTA CLARA, AND SAN MATEO COUNTIES 1955-1956, AND 1970

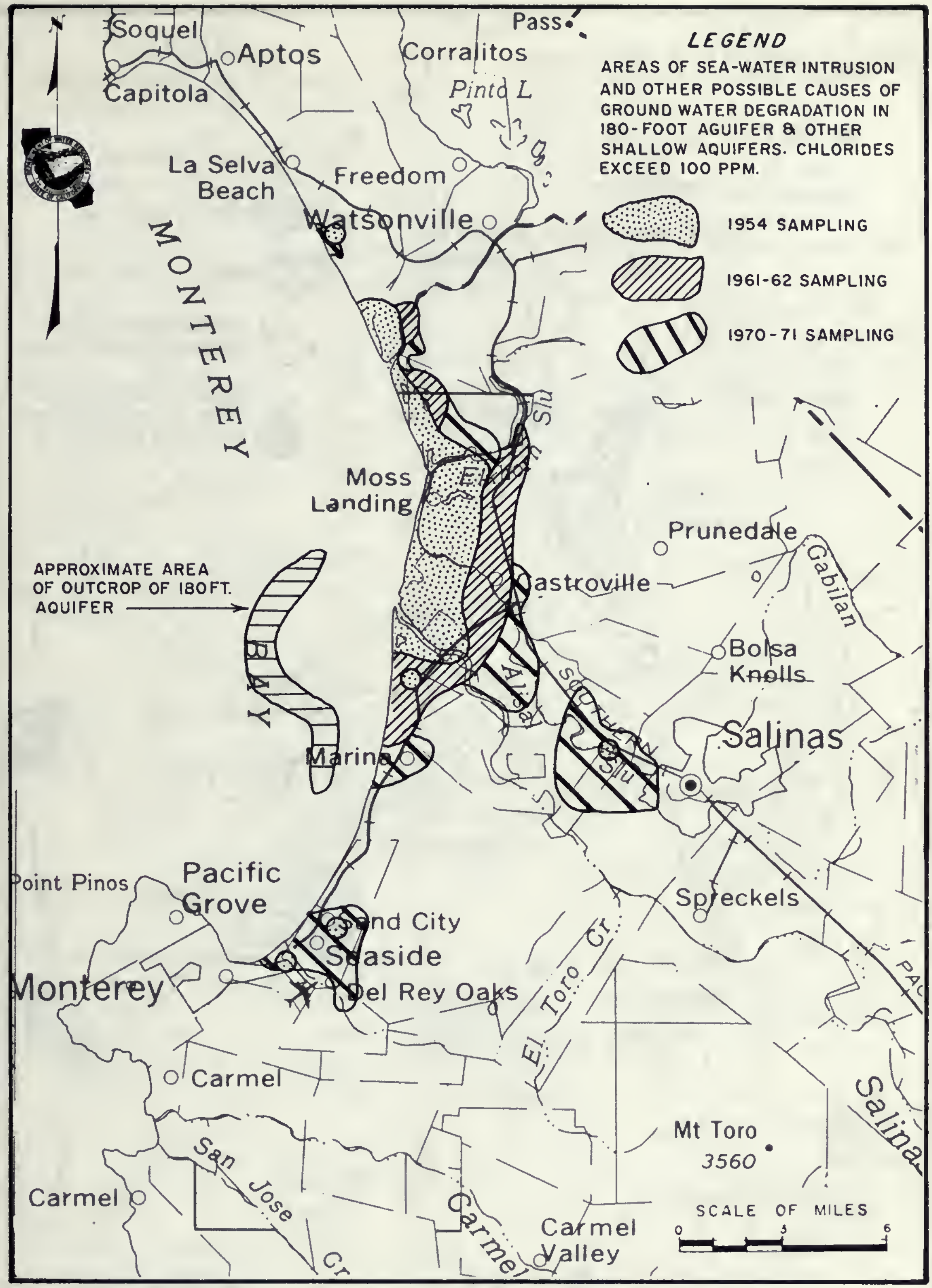


Figure 7. STATUS OF SEA-WATER INTRUSION AND DEGRADATION BY OTHER SOURCES IN THE 180-FOOT AQUIFER AND OTHER SHALLOW AQUIFERS, PAJARO AND SALINAS VALLEYS AND MONTEREY AREA, SANTA CRUZ AND MONTEREY COUNTIES 1954, 1961-1962, AND 1970-1971

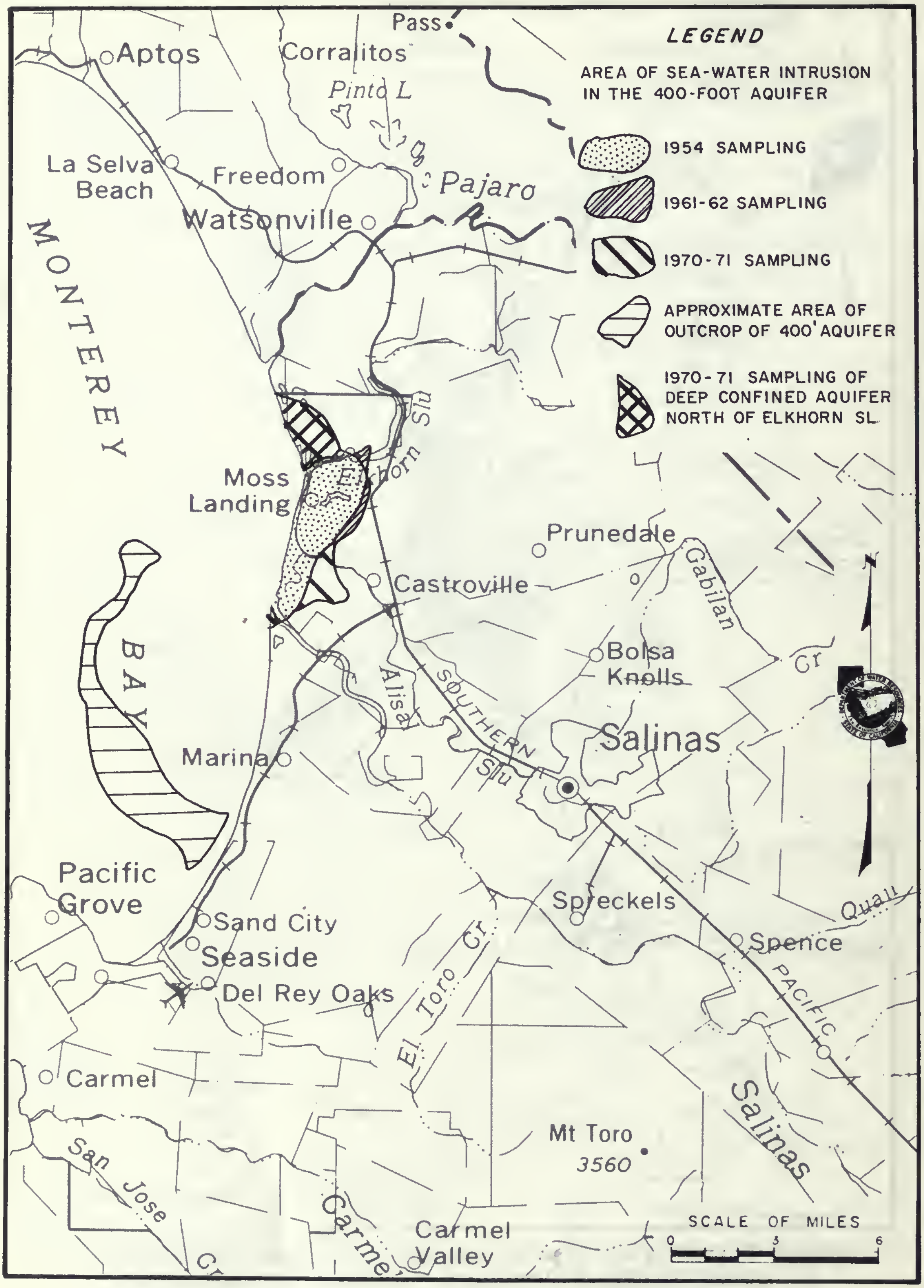


Figure 8. STATUS OF SEA-WATER INTRUSION IN THE 400-FOOT AQUIFER, SALINAS VALLEY, MONTEREY COUNTY 1954, 1961-1962, AND 1970-1971

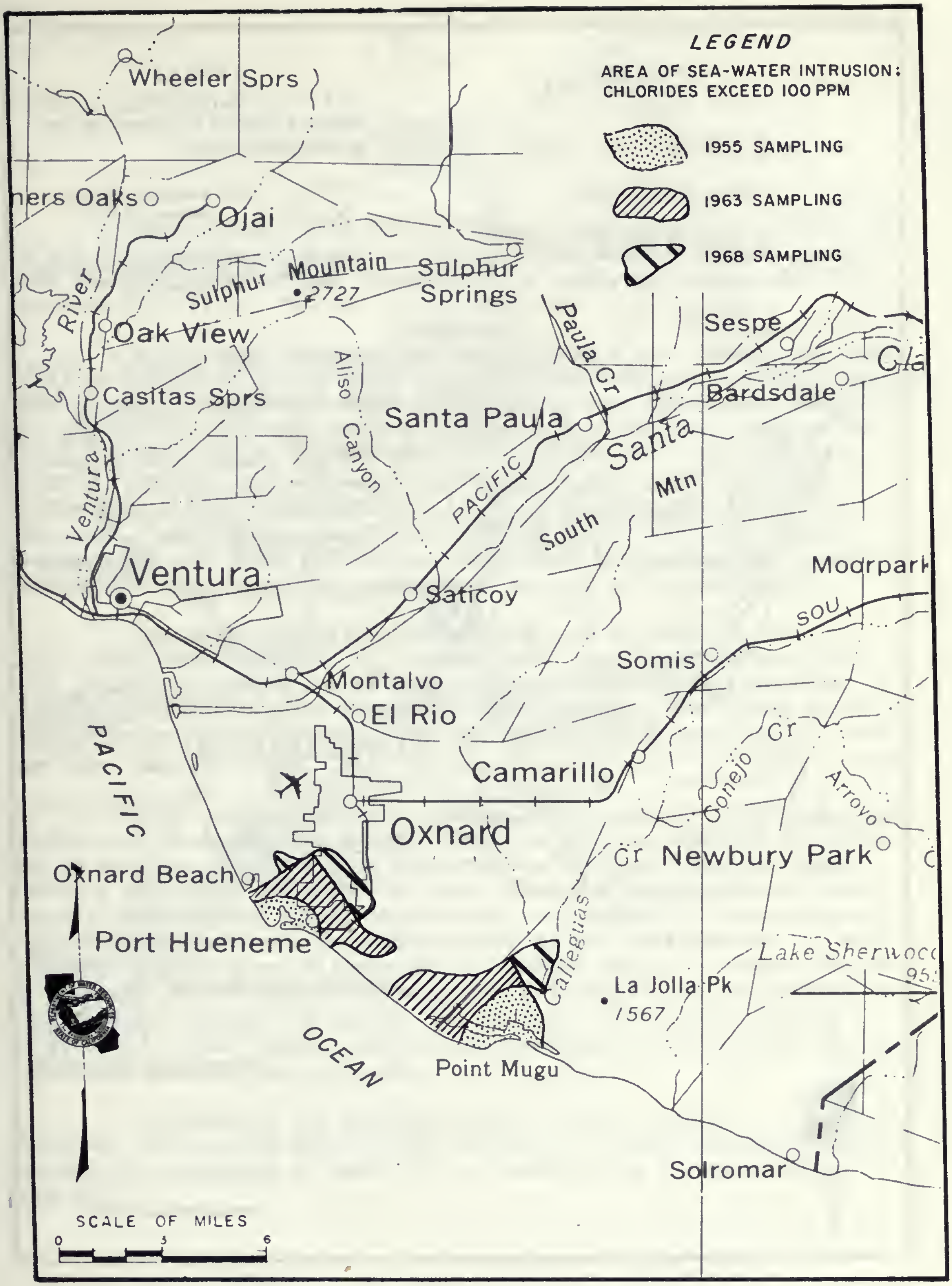


Figure 9. STATUS OF SEA-WATER INTRUSION,
SANTA CLARA RIVER VALLEY-OXNARD PLAIN, VENTURA COUNTY
1954-1955, 1963, AND 1970-1971

Figure 10. STATUS OF SEA-WATER INTRUSION AND DEGRADATION BY OTHER SOURCES, COASTAL PLAIN, LOS ANGELES AND ORANGE COUNTIES 1955 AND 1970-1971

INTRODUCTION TO CHAPTERS III, IV, V, AND VI

The detailed inventory of ground water basins in coastal and inland bay counties is keyed to Figure 11, an index map that appears on page 30. The inventory is presented in a county-by-county approach in Chapters III, IV, V, and VI.

Each county presentation begins with a map showing the locations of all known ground water basins in the area and an overall evaluation of the status of sea-water intrusion in each basin as of 1970-1971. The map is followed by a summary statement for the county and a bibliography of significant sources related to ground water occurrence and quality, geology, and sea-water intrusion in the area. Each basin evaluation covers the following: location, bibliographic references, water use, water-bearing sediments, ground water barriers, offshore geology, and sea-water intrusion. Many basin coverages also include tabulations of key mineral analyses of surface and ground water.

The basin identification system used in this bulletin, in which basins are numbered "1" through "262", was devised solely for this report and should not be confused with numbering systems used in other Department of Water Resources' publications. The total of 263 basins derives from the fact that two basins-- "93" and "93A" -- bear the same numeral.

Four coastal counties--Sonoma, Marin, San Francisco, and San Mateo--are bounded by the Pacific Ocean on one side and San Francisco Bay on another. Because some ground water basins in each of these counties lie along the ocean and some along the Bay shoreline, some counties necessarily appear twice--once to introduce a discussion of coastal basins and once for a discussion of Bay Area basins. To distinguish between them, discussions of coastal basins in these counties are headed, for example, "Sonoma County (Coastal)" and discussions of bay shoreline basins are headed, for example, "Sonoma County (Bay Shoreline)". Only Sonoma, Marin, San Francisco, and San Mateo Counties bear these special designations.

As guide to the material given in the remainder of this bulletin, all coastal ground water basins are listed alphabetically in Appendix A, beginning on page 369, and numerically in Appendix B, page 377.

Figure 11. INDEX TO MAPS SHOWING STATUS OF SEA-WATER INTRUSION IN CALIFORNIA 1970–1971

Figure	*County*	*Page*
12	Del Norte	34
13	Humboldt	42
14	Mendocino	58
15	Sonoma (coastal)	68
16	Marin (coastal)	78
17	San Francisco Bay Area*	92
18	San Francisco (coastal)	144
19	San Mateo (coastal)	150
20	Santa Cruz	162
21	Monterey	180
22	San Luis Obispo	206
23	Santa Barbara	238
24	Ventura	286
25	Los Angeles	298
26	Orange	318
27	San Diego	330

* Including Bay shorelines of Marin, Sonoma, Solano, Napa, Sacramento, San Joaquin, Contra Costa, Alameda, Santa Clara, San Mateo, and San Francisco Counties.

CHAPTER III

NORTHERN COASTAL BASINS

Del Norte County
Humboldt County
Mendocino County
Sonoma County
Marin County

DEL NORTE COUNTY

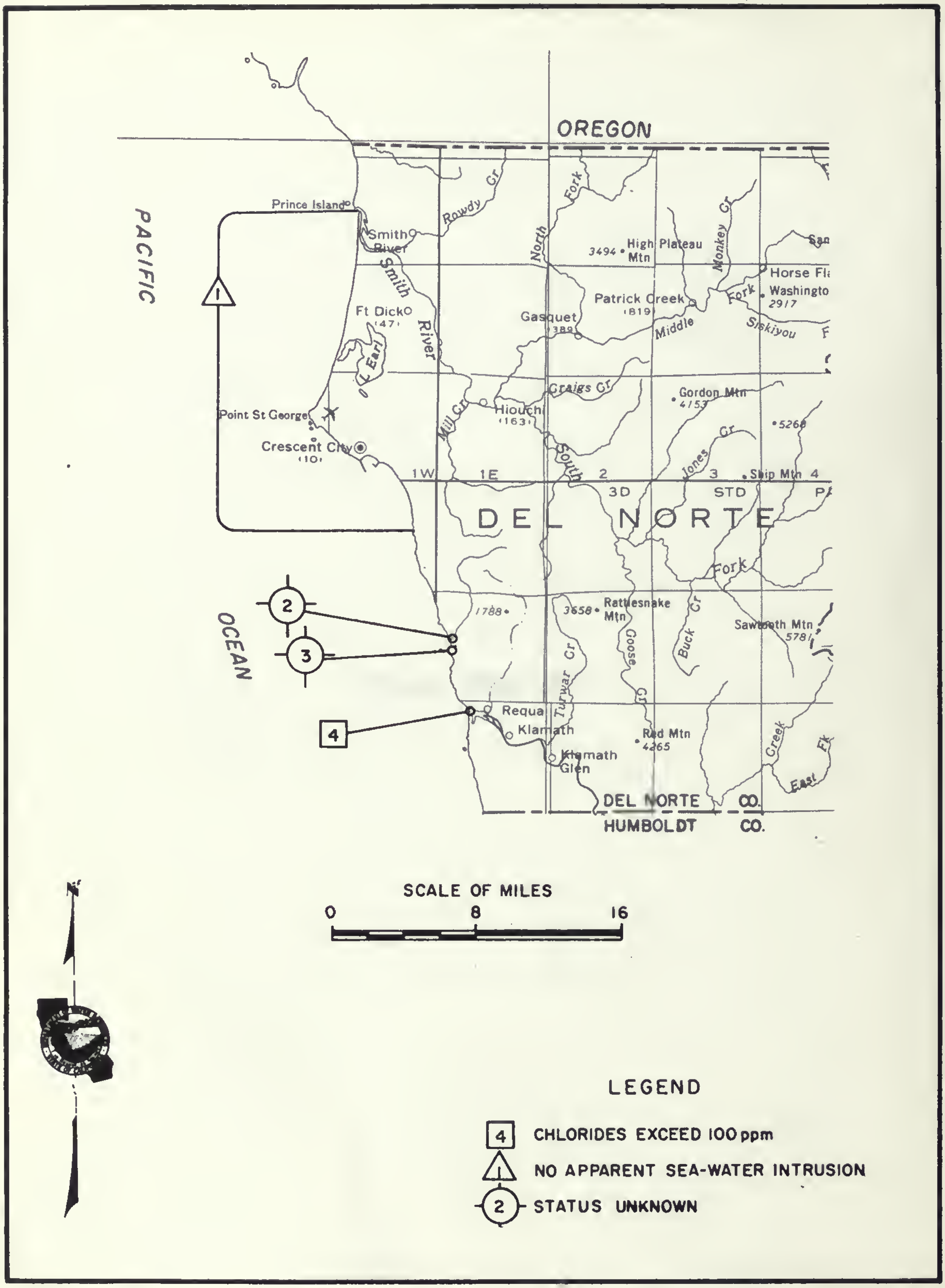


Figure 12. STATUS OF SEA-WATER INTRUSION,
DEL NORTE COUNTY
1970-1971

DEL NORTE COUNTY

The four identified ground water basins in coastal Del Norte County lie in valley-fill alluvium and marine terraces. They cover about 83 square miles and are open to the Pacific Ocean along about 20 miles of coastline (Figure 12).

The major coastal ground water basin is Basin 1. It covers about 70 square miles. Unconsolidated alluvium stores ground water in the Smith River flood-plain; a Pleistocene marine terrace (the Battery formation) stores it in the Crescent City area. Although total storage capacity, between depths of 10 to 35 feet, approaches 100,000 acre-feet, usable storage capacity is about 75,000 acre-feet. North of the Smith River, a thin marine coastal terrace provides minor quantities of ground water. The storage capacity of the remaining coastal basins of Del Norte County is unknown.

The potential for ground water storage offshore remains unknown. Smith River gravels in Basin 1 may extend offshore but probably do not contain fresh water.

The inventory did not cover consolidated rocks of the Franciscan formation. Weathering, jointing, and fracturing in these rocks have created some secondary porosity and permeability. Such formations may provide limited quantities of water for domestic use.

Except in Basin 4, the status of sea-water intrusion in Del Norte County has not changed between the 1954-55 inventory and 1970-71. In that basin, chlorides exceed 100 parts per million in a well which lies near Requa and within an area where tides affect the Klamath River. The cause of the high chlorides remains unknown.

Table 7. STATUS OF SEA-WATER INTRUSION, DEL NORTE COUNTY

Basin		1953-55	1970-71
No.	Name		
1	Smith River Plain	No apparent sea-water intrusion	No change
2	Wilson Creek	Status unknown	Status unknown
3	Cedar Mill	Status unknown	Status unknown
4	Lower Klamath River	No apparent sea-water intrusion	Chlorides exceed 100 ppm

BIBLIOGRAPHY

Del Norte County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, Weed Sheet. 1964.

California Department of Water Resources

2. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23.

3. Status of Sea-Water Intrusion. December 1960. Pp. 2-5. (Unpublished; drafted as Appendix A of Bulletin No. 63.)

4. Bulletin No. 74-3, Water Well Standards: Del Norte County. August 1966. 132 pages.

5. Bulletin No. 94-4, Land and Water Use in Smith River Hydrographic Unit. January 1965. 122 pages.

6. Bulletin No. 94-6, Land and Water Use in Klamath River Hydrographic Unit. May 1965. 174 pages.

7. Bulletin No. 105-3, North Coastal Area Action Program: A Study of the Smith River Basin and Plain. December 1970. 46 pages.

8. Bulletin No. 130 Series, Hydrologic Data; Volume I, North Coastal Area. 1963 through 1970.

9. Bulletin No. 142-1, Water Resources and Future Water Requirements: North Coastal Hydrographic Area, Southern Portion. 1965. 450 pages.

10. Bulletin No. 160-70, Water for California, The California Water Plan: Outlook in 1970. December 1970. 179 pages.

11. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

U. S. Bureau of Reclamation

12. Natural Resources of Northwestern California, Plans of Water Development. 1960. Report Appendix. Pp. 155-180.

U. S. Geological Survey

13. Professional Paper No. 600-C, Geology of the Klamath River Delta, California. 1968. Pp. C144-C148.

14. Water Supply Paper 1254, Geology and Ground Water Features of the Smith River Plain, Del Norte County, California. 1957. 76 pages.

15. Open-File Report, Ground Water Data as of 1967 North Coastal Subregion, California. March 5, 1969. Pp. 6-7.

16. Open-File Report, A Preurbanization Reconnaissance Study of Lake Earl, Del Norte County, California. December 3, 1971. 17 pages.

U. S. Department of the Interior, Pacific Southwest Field Committee

17. Preliminary Report, Summary of Ground-Water Conditions in Northwestern California. (In Natural Resources of Northwestern California, Water Resources Appendix). 1956. Pp. 19-28.

Del Norte County

SMITH RIVER PLAIN - BASIN 1

Location
Extends 16 miles north and 3 miles south from Crescent City.

Bibliography
Items 1, 4, 7, 12, 14, 16, 17. Page 36.

Description
An extensive alluvial plain and marine terrace. Area: 70 square miles. Maximum width: 6 miles. Coastline: 19 miles.

Water Use
Ground and surface waters are moderately developed for agriculture, homes, cities, and industry. Crescent City is quite urban. Floriculture, irrigated pasture, and natural stock grazing dominate the agricultural lands near Smith River. Forests cover portions of central and southern marine terraces.

Water-bearing Sediments
In the northern part of the basin, unconsolidated river terrace and floodplain deposits locally attain a thickness of 95 feet over the bedrock. To the south, marine terraces whose thickness averages 35 feet overlie the bedrock. Coastal sand dunes lie between Smith River and Crescent City. A bedrock of consolidated marine sediments, essentially nonwaterbearing, appears at shallow depths.

Storage capacity at depths between 10 and 35 feet is about 100,000 acre-feet, of which 75,000 acre-feet probably is usable. The permeability of both river terrace and floodplain is high to moderate; their water-yielding capacity is high. That of the marine terraces is moderate to low; their water-yielding capacity is low. Both permeability and water-yielding capacity of the sand dunes is moderate.

Ground Water Barriers
Four miles inland, the Del Norte fault parallels the northern shoreline. Whether this fault blocks the movement of ground water is unknown.

Offshore Geology
River terrace and floodplain deposits in the northern part of the basin may be on the order of 95 feet in thickness, but mostly are unknown. These deposits probably extend seaward. The continental shelf, several miles wide in this area, is not incised by submarine canyons.

Sea-water Intrusion
No evidence of sea-water intrusion existed in the fall of 1970. Throughout the basin, the hydraulic gradient is seaward. The ground water moves from the mountain front toward Lake Earl and the coast. Along the coast, it is largely unconfined. In fall, 1970, it stood from one-half foot to 10 feet above sea level. Throughout the past 17 years, the fluctuation of water levels in six wells studied has not changed significantly. An increase in pumping along the northern coast, by lowering water levels below sea level, could reverse the hydraulic gradient and subject the ground water basin to the intrusion of sea water from the ocean or brackish water from Lake Earl. Sea water cannot enter the marine terraces to the south because they rest upon bedrock at or above sea level.

Table 8. MINERAL ANALYSES, BASIN 1, SMITH RIVER PLAIN

Item	Surface Water Station	Water Wells, by Owner								
	Smith River near Crescent City	Ship-Ashore	Harry Tedson of Fort Dick	Guy Labarra of Eureka	Tedson Brothers of Fort Dick	Eva Mello of Smith River	Redwood School of Fort Dick	Old Coast Guard Station	Albert Short of Crescent City	Doris Storey of Crescent City
Base and Meridian	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt
Location Number	16N/1E-10	18N/1W-17R4	18N/1W-34M2	17N/1W-4J1	17N/1W-3E1	17N/1W-2G1	17N/1W-14C2	16N/2W-13E1	16N/1W-2Q1	16N/1W-20H1
Date Sampled	5-12-70	8-27-69	8-30-61	8-30-61	7-17-67	8-30-61	7-11-68	6-24-70	Summer 1962	8-29-61
Analysis by	DWR*	DWR	DWR	DWR	DWR	DWR	DWR	DWR	USGS **	DWR
Well Use	-	Domestic	Domestic, stock	Irrigation	Domestic, Stock	Irrigation	Domestic	Domestic	Domestic	Domestic
Well Depth, in feet		38	27	35	25	50	40	30	30	31
Character	$MgHCO_3$	—	—	—	—	—	—	—	—	—
Temperature (°F)	46.4	69	—	—	57	—	64	58	—	—
EC (Micromhos @ 25° C)	101	270	356	250	358	107	206	266	229	167
pH	7.8	7.7	7.6	7.7	8.1	6.9	8.1	6.6	8.2	7.2
Percent Sodium		23	4	8	6	28	9	49	29	35
CONSTITUENTS, in parts per million										
Total Dissolved Solids	46	162	221	157	168	72	100	157	146	106
Hardness as $CaCO_3$										
Total	48	110	191	127	172	38	89	66	88	50
Noncarbonate	2	0	9	5	11	0	5	—	0	13
Aluminum	—	—	0.00	0.01	—	0.01	—	—	0.00	0.00
Arsenic	—	—	0.00	0.00	—	0.00	—	—	0.00	0.00
Bicarbonate: HCO_3	56	134	222	149	196	47	102	69	133	45
Boron	0.0	0.0	0.07	0.04	0.0	0.03	0.0	0.0	0.0	0.06
Calcium	6.6	18	15	6.5	9.4	4.8	2.9	11	16	5.0
Carbonate: CO_3	0.0	0	0	0	0	0	0	0	0	0
Chloride	3.5	18	5.8	8.1	8.7	7.8	9.0	42	13	17
Copper	—	—	0.00	0.00	—	0.00	—	—	0.00	0.00
Fluoride	—	—	0.0	0.1	—	0.1	—	—	0.0	0.1
Iron	—	—	0.02	0.02	—	0.02	—	—	7.2	0.59
Lead	—	—	0.00	0.00	—	0.00	—	—	0.00	0.00
Magnesium	7.7	16	37	27	36	6.3	20	9.4	12	9.1
Manganese	—	—	0.00	0.00	—	0.00	—	—	0.00	0.00
Nitrate: NO_3	0.1	0.3	5.3	2.2	8.5	4.2	6.6	1.8	0.5	15
Potassium	0.6	0.4	0.8	0.4	7.9	0.2	1.4	1.4	0.4	0.6
Silica: SiO_3	—	—	40	34	—	18	—	—	38	17
Sodium	1.7	15	3.8	4.8	5.0	6.8	4.2	30	17	13
Sulfate: SO_4	1.6	1.6	4.0	0.8	7.7	1.2	2.0	10.0	1.0	6.7
Zinc	—	—	0.07	0.06	—	0.12	—	—	0.02	0.08

* California Department of Water Resources
** U. S. Geological Survey

Del Norte County

WILSON CREEK BASIN - BASIN 2
CEDAR MILL BASIN - BASIN 3

Location	12 miles south of Crescent City.
Bibliography	Items 1, 4. Page 36.
Description	Two small alluvium-filled valleys extending northeast from the coast. Total area: 0.6 square miles. Total coastline: 1,700 feet.
Water Use	Surface water supplies grazing stock and a lumber mill. Ground water not developed.
Water-bearing Sediments	Unconsolidated alluvium whose thickness and physical characteristics remain unknown.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available as of 1970. Fresh water inflow probably maintains a seaward hydraulic gradient.

Table 9. MINERAL ANALYSES, BASINS 2 and 3,
WILSON CREEK AND CEDAR MILL

Item	Wilson Creek	Cedar Mill Creek
Character	$CaHCO_3$	Unknown
Total Dissolved Solids	Low	Low
Chlorides	Low	Low

Del Norte County

LOWER KLAMATH RIVER BASIN - BASIN 4

Location	16 miles south of Crescent City.
Bibliography	Items 1, 4. Page 36.
Description	Narrow, alluvium-filled valley extending east from coast. Area: 12 square miles. Coastline: 4,500 feet.
Water Use	Homes, farms, and lumber mills associated with Klamath and Requa use both surface and ground water.
Water-bearing Sediments	Unconsolidated alluvium, coarse sand, and gravel deposits whose thickness is at least 108 and possibly 200 feet.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	In 1970 chlorides exceeded 100 ppm in a well on the right bank near Requa within tidal influence. By comparison, inland areas have less than 100 ppm. The high chloride problem appeared to be unique to this one well. Future development in this reach of the river may reverse the hydraulic gradient and encourage intrusion of brackish or saline water in the Klamath River.

Table 10. MINERAL ANALYSES, BASIN 4, LOWER KLAMATH RIVER

Item	Surface Water Station	Water Wells	
	Klamath River near Klamath	Most Wells	A Well in Alluvium
Base and Meridian	Humboldt	-	-
Location Number	13 N/1E-24	-	-
Date Sampled	5-11-70	-	-
Analysis by	DWR*	-	-
Character	$CaHCO_3$	$CaMgHCO_3$	$NaHCO_3$
Temperature (°F)	52	-	-
EC (Micromhos @ 25° C)	145	-	-
pH	7.8	-	-

CONSTITUENTS, in parts per million

Total Dissolved Solids	90	Fluoride	0.1
Hardness as $CaCO_3$		Gallium	0.01
Total	62	Lead	0.00
Non-carbonate	1	Magnesium	6.6
		Manganese	0.00
Aluminum	0.00	Molybdenum	0.00
Beryllium	0.00	Nickel	0.00
Bicarbonate: HCO_3	7.4	Nitrate: NO_3	0.1
Bismuth	0.00	Potassium	0.9
Boron	0.04	Silica: SiO_2	12
Cadmium	0.00	Sodium	5.0
Calcium	14	Sulfate: SO_4	13
Carbonate: CO_3	0.0	Titanium	0.00
Chloride	2.1	Vanadium	0.00
Chromium	0.00	Zinc	0.01
Copper	0.00		

* California Department of Water Resources

HUMBOLDT COUNTY

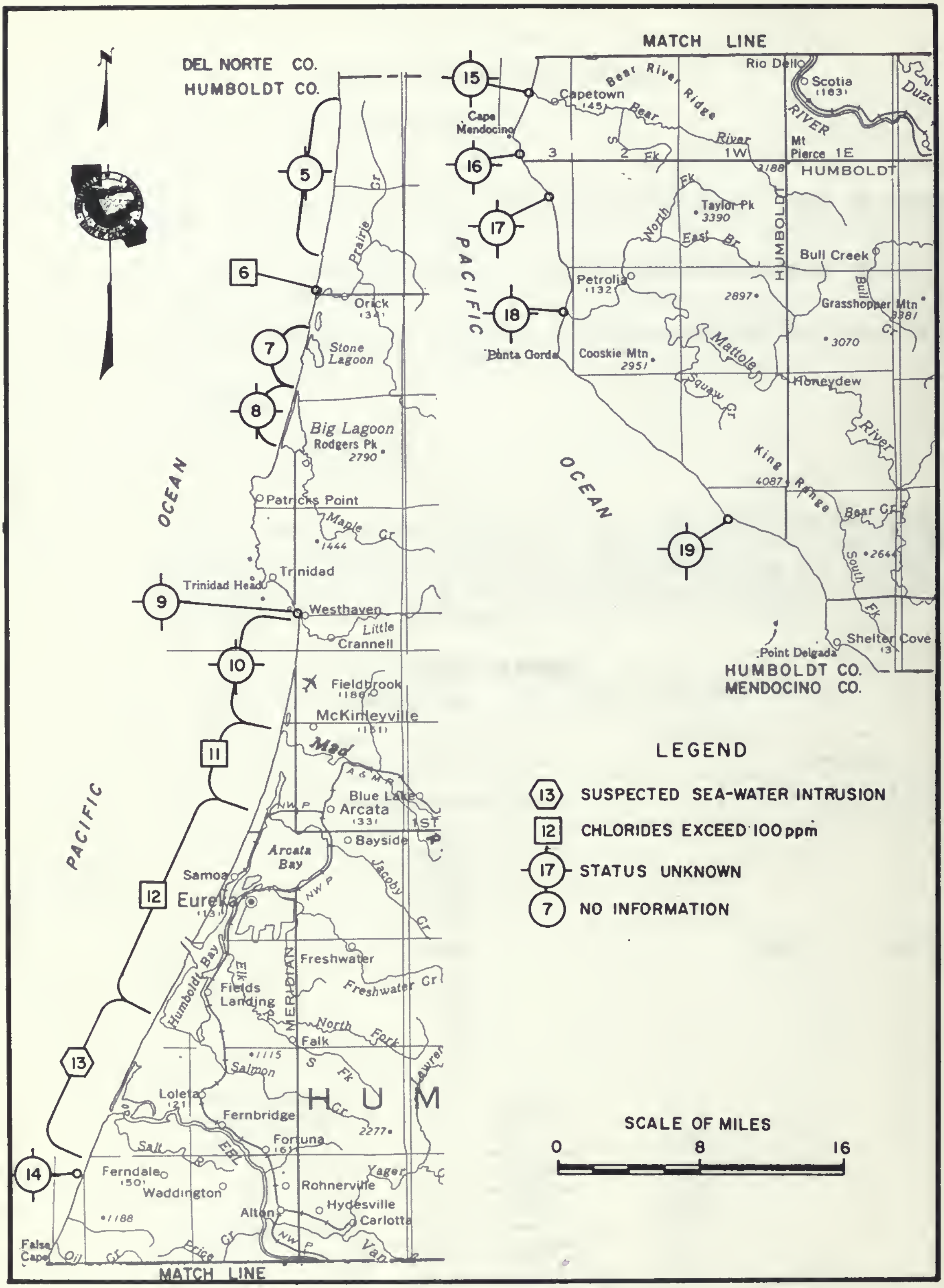


Figure 13. STATUS OF SEA-WATER INTRUSION, HUMBOLDT COUNTY 1970-1971

The 15 identified ground water basins in coastal Humboldt County lie in valley-fill alluvium, dune-covered marine terraces, and older, slightly compacted sediments. They cover about 200 square miles and are open to the Pacific Ocean along about 45 miles of coastline.

The major coastal ground water area, near Eureka, covers about 142 square miles, and includes Basins 9 through 13. Unconsolidated Quaternary alluvium stores ground water in these five areas, as do the Pleistocene Hookton formation, the Plio-Pleistocene Carlotta formation, and unnamed sediments of late Tertiary and Quaternary age. The storage capacity of the alluvium in the Arcata Plain portion of Basin 11 approaches 11,000 acre-feet, while that of the alluvium in the lower and middle sections of Basin 13 approaches 79,000 acre-feet. In Basin 11, ground water occurs at depths of 15 to 25 feet; in Basin 13, at depths of 10 to 40 feet. The storage capacity of the remaining sediments in these two basins, together with that in the remaining coastal basins of Humboldt County, is unknown.

The potential for ground water storage offshore remains unknown, although aquifers most likely appear offshore from Basins 10, 11, 13, and perhaps from Basin 5.

The inventory did not cover consolidated rocks of the Franciscan formation, undivided sedimentary rocks of the Cretaceous Period, or metasedimentary rocks from pre-Cretaceous periods. Weathering, jointing, and fracturing in such rocks have created some secondary porosity and permeability. Such formations may provide limited quantities of water for domestic use.

Except in Basin 11, the status of sea-water intrusion in Humboldt County has not changed between 1954 and 1970. In that basin, ground water quality in the plain area has improved.

Table 11. STATUS OF SEA-WATER INTRUSION, HUMBOLDT COUNTY

Basin		1953-55	1970-71
No.	Name		
5	Prairie Creek Area	Status unknown	Status unknown
6	Redwood Creek Basin	Chlorides exceed 100 ppm	No change
7	McDonald Creek Basin	No apparent sea-water intrusion	No information
8	Maple Creek Basin	Status unknown	Status unknown
9	Little River Basin	Status unknown	Status unknown
10	Dows Prairie Area	Status unknown	Status unknown
11	Mad River Valley and Plain	Chlorides exceed 100 ppm	No change in coastal Mad River Valley; quality improved south of Arcata
12	Eureka Plain	Chlorides exceed 100 ppm on North Spit; no apparent sea-water intrusion in main basin	No change
13	Eel River Valley	Suspected sea-water intrusion	Known sea-water intrusion
14	Fleener Creek Basin	Status unknown	Status unknown
15	Bear River Basin	Status unknown	Status unknown
16	Singley Creek Terrace	Status unknown	Status unknown
17	Davis Creek Terrace	Status unknown	Status unknown
18	Mattole River Basin	Status unknown	Status unknown
19	Big Flat Creek Basin	Status unknown	Status unknown

BIBLIOGRAPHY

Humboldt County

California Division of Mines and Geology

1. Geologic Map of California, Redding Sheet. 1962.

2. Geologic Map of California, Weed Sheet. 1964.

California Department of Water Resources

3. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23.

4. Status of Sea-Water Intrusion. December 1960. Pp. 5-19. (Unpublished; drafted as Appendix A of Bulletin No. 63.)

5. Bulletin No. 66-59, Quality of Ground Waters in California; Part I, "Northern and Central California". February 1963. Pp. 35-38. Unnumbered plates.

6. Bulletin No. 66-62, Quality of Ground Waters in California; Part I, "Northern and Central California". August 1964. Pp. 26-27. Plate 2.

7. Bulletin No. 94-6, Land and Water Use in Klamath River Hydrographic Unit. May 1965. 174 pages.

8. Bulletin No. 94-7, Land and Water Use in Mad River -- Redwood Creek Hydrographic Unit. April 1965. 118 pages.

9. Bulletin No. 94-8, Land and Water Use in Eel River Hydrographic Unit. August 1965. 134 pages.

10. Bulletin No. 105-2, North Coastal Area Action Program: A Study of the McKinleyville-Trinidad Area". February 1969. 42 pages.

11. Bulletin No. 130 Series, Hydrologic Data; Volume I, North Coastal Area. 1963 through 1970.

12. Bulletin No. 142-1, Water Resources and Future Water Requirements: North Coastal Hydrographic Area, Southern Portion. 1965. 450 pages.

13. Bulletin No. 160-70, Water for California, The California Water Plan: Outlook in 1970. December 1970. 179 pages.

14. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

15. District Report, Sea-Water Intrusion and Ground Water Monitoring Programs in the Eureka Area. June 1973. 17 pages.

U. S. Bureau of Reclamation

16. Natural Resources of Northwestern California, Plans of Water Development. 1960. Report Appendix. Pp. 3-80.

U. S. Geological Survey

17. Professional Paper No. 600-C, Geology of the Klamath River Delta, California. 1968. Pp. C144-C148.

18. Water Supply Paper 1470, Geology and Ground Water Features of the Eureka Area, Humboldt County, California. 1959. 80 pages.

19. Open-File Report, Ground Water Data as of 1967, North Coastal Subregion, California. March 5, 1969. Pp. 8-9.

U. S. Department of the Interior, Pacific Southwest Field Committee

20. Preliminary Report, Summary of Ground-Water Conditions in Northwestern California. (In Natural Resources of Northwestern California, Water Resources Appendix). 1956. Pp. 63-74, 91-92.

PRAIRIE CREEK AREA - BASIN 5

Location	24 miles south of Crescent City and mainly within Prairie Creek Redwoods State Park and Redwood National Park.
Bibliography	Items 2, 4, 14, 20. Page 44.
Description	Continental sediments. Area: 40 square miles. Maximum width: 4 miles. Coastline: 7 miles.
Water Use	Development of surface water limited. Development of ground water unknown.
Water-bearing Sediments	Cobble conglomerate, sandstone and siltstone, all slightly deformed and poorly consolidated, comprise the overlying sediments; about 1,500 feet thick. Ground water occurs in these sediments and to a very limited extent in weathered and jointed bedrock comprised of consolidated marine sediments and metamorphic rock.
Ground Water Barriers	None known.
Offshore Geology	The onshore northwest-trending structure continues offshore, where continental sediments coalesce into a continuous blanket with other sediments of about the same age. Submarine canyons do not appear nearby.
Sea-water Intrusion	No information available as of 1970-71. Fresh water inflow probably is sufficient to maintain a seaward hydraulic gradient.

REDWOOD CREEK BASIN - BASIN 6

Location	32 miles south of Crescent City.
Bibliography	Items 2, 4, 12. Page 44.
Description	Alluvium-filled valley extends east from coast. Area: 3 square miles. Coastline: 4,200 feet.
Water Use	Stock grazing, lumbering, and homes at Orick. Development of both surface and ground water is limited.
Water-bearing Sediments	Unconsolidated alluvium whose thickness and physical characteristics remain unknown.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	In 1970, as in 1954, chloride concentrations approached 130 ppm in an area of degraded ground water adjacent to the coast. Inland, concentrations do not exceed 10 ppm. Fresh water inflow probably maintains a seaward hydraulic gradient; information unavailable.

Table 12. MINERAL ANALYSES, BASIN 6, REDWOOD CREEK

Item	Surface Water	Ground Water	
	Redwood Creek at Orick	Coastal	Inland
Base and Meridian	Humboldt		
Location Number	1N/1E-4A		
Date Sampled	5-12-70		
Analysis by	DWR*		
Character	$CaHCO_3$	NaCl	$NaHCO_3$
Temperature (°F)	48		
EC (Micromhos @ 25° C)	103		
pH	7.6		
CONSTITUENTS, in parts per million			
Total Dissolved Solids	56		
Hardness as $CaCO_3$			
Total	44		
Noncarbonate	10		
Bicarbonate: HCO_3	42		
Boron	0.1		
Calcium	14		
Carbonate: CO_3	0.0		
Chloride	4.9		
Magnesium	2.2		
Nitrate: NO_3	0.6		
Potassium	1.4		
Sodium	3.2		
Sulfate: SO_4	9.2		

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McDONALD CREEK BASIN - BASIN 7
MAPLE CREEK BASIN - BASIN 8

Location	38 miles south of Crescent City. McDonald Creek Basin lies within Dry Lagoon Beach State Park.
Bibliography	Items 2, 4, 14. Page 44.
Description	Two small alluvium-filled valleys terminating in lagoons separated from the ocean by barrier beaches. Combined area: 1.5 square miles. Combined coastline: 4.5 miles.
Water Use	Stock grazing and lumber mill.
Water-bearing Sediments	Unconsolidated alluvium and sand bars in lagoons. Thickness and physical characteristics remain unknown.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-Water Intrusion	No information available as of 1970-71. Fresh-water inflow probably maintains seaward hydraulic gradient.

Table 13. MINERAL ANALYSES, BASIN 7, McDONALD CREEK

Item	Surface Water	Ground Water
	McDonald Creek	Alluvium
Character	$NaCaHCO_3$	$NaCaHCO_3$
Total Dissolved Solids	Low	Low
Chlorides	Low	Low

LITTLE RIVER BASIN - BASIN 9
DOWS PRAIRIE AREA - BASIN 10

Location	10 to 16 miles north of Eureka.
Bibliography	Items 1, 2, 4, 10, 18, 20. Page 44.
Description	Low to moderate relief. Dows Prairie Area is an elevated terrace; Little River Basin is an alluvial valley resting on that terrace. In both basins, sand dunes extend along the coast. Total area: 21 square miles. Total coastline: 5.8 miles.
Water Use	Homes and small commercial and light industrial developments are scattered through a semiurban area where stock graze on irrigated pasture. Surface and ground water are moderately developed.
Water-bearing Sediments	In both basins, sand, silt, clay, and gravel--all poorly concolidated and almost flat-lying--form an elevated terrace of continental sediments 150 to 200 feet thick. These sediments, of moderately low permeability, contain unconfined ground water; wells, however, supply only homes and light industry. At the north, overlying the terrace, is the Little River Basin, whose fine-grained alluvium, about 50 feet thick, contains channel gravels. Ground water here also is unconfined. Under both basins, marine sediments--deformed, consolidated, and essentially nonwater-bearing--comprise the bedrock.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information was available in the two basins as of 1970-1971. In both basins, fresh water inflow probably maintains a seaward hydraulic gradient. In Dows Prairie Area, ground water is of good quality ($NaClHCO_3$ type), with low chlorides and total dissolved solids.

Humboldt County

MAD RIVER VALLEY AND PLAIN - BASIN 11

Location	8 miles north of Eureka.
Bibliography	Items 1, 10, 15, 16, 18, 20. Page 44.
Description	Inland from coastal dunes, the alluvium of the Arcata Plain stops at an eastern upland formed by the outcropping Hookton formation and broken only by the Mad River, which flows westward from the alluvium-filled Blue Lake Valley. Area of Arcata Plain: 16 square miles. Coastline: 6 miles.
Water Use	General development of surface and ground water serves irrigated pasture, farms, industries, and homes in and about Arcata. Ground water in the dunes remains undeveloped.
Water-bearing Sediments	The Arcata Plain contains the sand, silt, clay, and gravel of the continental Hookton formation. This formation, overlain by up to 100 feet of unconsolidated alluvium, outcrops in the eastern upland. It possesses moderate permeability, contains largely unconfined ground water, and yields moderate to large amounts of water to wells. Storage capacity at depths of 10 to 15 feet approaches 11,000 acre-feet. An essentially nonwater-bearing bedrock of consolidated marine sediments probably underlies the entire area. Throughout the past 14 years, the fluctuation pattern of water levels in one Arcata well has not changed significantly. It is not known whether the ground water in the coastal dunes, whose thickness sometimes reaches 100 feet, is in hydrologic continuity with ground water of the Arcata Plain sediments.
Ground Water Barriers	None known.
Offshore Geology	The water-bearing sediments, whose base lies several hundred feet below sea level, probably extend seaward. The continental shelf, several miles wide, is not incised by submarine canyons.
Sea-water Intrusion	Degradation of the shallow alluvial aquifers by sea-water intrusion has been apparent since at least 1950 in the tidal region of the Mad River area. The areal extent of degradation is limited to portions of the basin lying near Arcata Bay. No monitored wells in the area evidenced a high chloride content in 1972. No degradation of the deep, confined Hookton formation has occurred. The problem appears to have remained unchanged in the past 20 years and will probably continue unchanged as long as the pumping pattern and withdrawals are not significantly altered.

Table 14. MINERAL ANALYSES, BASIN 11, MAD RIVER VALLEY AND PLAIN

Item	Surface Water Station	Water Wells, by Owner							
	Mad River near Arcata	Earl W. Dare of McKinleyville	Mulcahy of Arcata	Charles Barber	H. Miller & Sons of McKinleyville	Simpson Timber Company of Arcata	Mrs. Elmer North	Arcata Plywood Corporation	Jacoby Creek School
Base and Meridian	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt
Location Number	6N/1E-15D	6N/1W-1H1	6N/1E-7M1	6N/1E-8H1	6N/1E-17D1	6N/1E-19Q1	6N/1E-30N1	6N/1E-32F1	5N/1E-4H4
Date Sampled	5-12-70	7-23-65	9-8-69	7-23-65	6-25-68	7-23-65	7-23-65	11-3-66	7-19-67
Analysis by	DWR*	DWR	DWR	USGS**	DWR	DWR	USGS	DWR	DWR
Well Use		Domestic, Irrigation	Domestic Irrigation	Domestic	Irrigation	Domestic, Stock	Domestic, Irrigation	Industrial	Domestic
Well Depth, in feet		31	20	157	457	108	37	640	125
Character	$CaHCO_3$								
Temperature (°F)	50		65	-	56				65
EC(Micromhos @ 25° C)	114	123	484	207	448	365	345	742	454
pH	7.6	7.6	7.6	7.9	8.2	8.5	8.6	7.6	7.7
Percent Sodium		57	14	33	7	10	10	75	33
CONSTITUENTS, in parts per million									
Total Dissolved Solids	80	70	223	143	226	225	219	425	208
Hardness as $CaCO_3$									
Total	48	21	230	57	207	184	169	79	154
Noncarbonate	5	0	0	16	21	0	0	0	0
Aluminum	0.01								
Beryllium	0.00								
Bicarbonate: HCO_3	52	26	287	50	227	212	193	279	204
Bismuth	0.00								
Boron	0.1	0	0.1	0	0.1	0	0	0.5	0.0
Cadmium	0.00								
Calcium	15	5.6	37	11	41	52	50	6.9	26
Carbonate: CO_3	0.0	0	0	0	0	7	9	0	0
Chloride	4.8	18	23	15	16	11	12	88	32
Chromium	0.00								
Cobalt	0.00								
Copper	0.00								
Gallium	0.01								
Germanium	0.00								
Iron	0.08								
Lead	0.00								
Magnesium	2.6	1.7	34	7.2	26	13	11	15	22
Molybdenum	0.00								
Nickel	0.00								
Nitrate: NO_3	0.5	2.3	1.3	9.5	0.1	0.7	1.1	1.7	0.6
Potassium	1.4	0.7	2.6	3.6	2.3	1.2	1.2	7.5	4.3
Sodium	3.8	14	18	14	7.8	9.9	9.0	123	36
Sulfate: SO_4	7.2	5.0	2.0	21	18	3.0	1.0	3.3	16
Titanium	0.00								
Vanadium	0.00								
Zinc	0.01								

* California Department of Water Resources
** U. S. Geological Survey

Humboldt County

EUREKA PLAIN - BASIN 12

Location	Extends 12 miles south from Manila through Eureka to the south shore of Humboldt Bay.
Bibliography	Items 1, 15, 16, 18, 20. Page 44.
Description	Humboldt Bay, separated from the Pacific Ocean by North Spit and South Spit, occupies the western part of the basin. To the north, Freshwater Creek, and to the south, Elk River and Salmon Creek empty into the bay. These streams have well-developed alluvial valleys and, near their mouths, tidal flats. They dissect the gently rolling terrace of Eureka Plain. Area: 70 square miles. Coastline: 13 miles.
Water Use	Water from Mad River supplies Eureka, which extends along one-third of Humboldt Bay shore. Land use is urban and industrial, plus much pasturage. Moderately developed ground water supplies some homes, farms, and industries.
Water-bearing Sediments	Marine sediments, fine-grained, poorly consolidated, and probably poorly water-bearing, underlie the area. Above these sediments lie the sand, silt, clay, and gravel of the continental Hookton formation, 400 and more feet thick. This formation caps ridges and hills. Its aquifers, commonly confined, supply most of the ground water pumped. Unconsolidated alluvium, mostly fine sand, silt, clay, overlies the Hookton formation close to Humboldt Bay and in nearby valleys whose streams dissect stream terrace deposits. Although both the alluvium and the terraces contain unconfined ground water, yields to wells are low. Along the coast lie dunes at least 100 feet thick that contain fresh, unconfined ground water. A few wells on North Spit tap this water. Recent water level measurements are unavailable.
Ground Water Barriers	None known.
Offshore Geology	The water-bearing sediments, whose base lies several hundred feet below sea level, probably extend seaward. Offshore, the structural trend continues northwest. The continental shelf, several miles wide, is incised by the Eel Submarine Canyon 11 miles southwest.
Sea-water Intrusion	Based on the 1972 monitoring program, the basin shows very little evidence of sea-water intrusion. Earlier studies indicate that shallow alluvial aquifers surrounding Arcata and Humboldt Bay and parts of North Spit have been degraded by sea water. These aquifers lack continuity with the deeper confined aquifers of the Hookton formation and currently are not a hazard to them. The deeper aquifers are under artesian pressure that prevents the degraded water from percolating into them. Unless conditions change, degradation of the Hookton aquifers by sea water is not likely.

Table 15. MINERAL ANALYSES, BASIN 12, EUREKA PLAIN

Item	Surface Water Stations			Water Wells, by Owner					
	Freshwater Creek	Elk River	Salmon Creek	D. C. Lindstrom	Arcata Redwood Company	L. L. Spinney	Pacific Gas & Electric Co.		Pete Lorensen
Base and Meridian	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt
Location Number	-	-	-	5N/1W-29Q1	5N/1E-18Q1	5N/1E-20Q1	4N/1W-8P1	4N/1W-17B1	4N/1W-16H1
Date Sampled	-	-	-	6-24-68	6-24-70	7-23-65	8-29-63	8-29-63	8-28-65
Analysis by	DWR*	DWR	DWR	DWR	DWR	USGS**	DWR	USGS	USGS
Well Use	-	-	-	Domestic	Domestic, Industrial	Domestic	Industrial	Industrial	Stock
Well Depth, in feet	-	-	-	16	375	157	450	450	210
Character	$MaCaHCO_3$	$NaMgHCO_3$	$NaHCO_3$						
Total Dissolved Solids	Low	Low	Low						
Chlorides	Low	Low	Low						
Temperature (°F)				59	62		55		
EC (Micromhos @ 25° C)				290	801	269	168	171	495
pH				7.9	7.4	8.0	7.6	7.6	8.6
Percent Sodium				33	74	37	31	32	24
CONSTITUENTS, in parts per million									
Total Dissolved Solids				153	468	179	93	98	313
Hardness as $CaCO_3$									
Total				84	104	84	52	54	196
Noncarbonate				31		0	0	0	0
Aluminum							0.10	0.13	
Arsenic							0.00	0.01	
Bicarbonate: HCO_3				65	330	108	65	67	240
Boron				0.1	1.2	0	0.0	0.0	0.1
Calcium				7.3	19	14	5.9	7.5	38
Carbonate: CO_3				0	0	0	0	0	13
Chloride				26	101	30	14	15	28
Copper							0.00	0.00	
Iron								0.25	
Lead							0.00	0.00	
Magnesium				16	14	12	9.1	8.6	25
Manganese							0.01	0.01	
Nitrate: NO_3				38	3.5	0.4	1.2	1.4	7.4
Potassium				2.4	5.7	1.6	1.5	1.5	3.7
Sodium				20	143	23	11	12	29
Sulfate: SO_4				16	0.0	4	3.1	3.3	4.0
Zinc							0.01	0.01	

* California Department of Water Resources
** U. S. Geological Survey

Humboldt County

EEL RIVER VALLEY - BASIN 13

Location	11 miles south of Eureka.
Bibliography	Items 1, 5, 6, 15, 16, 18, 20. Page 44.
Description.	Coastal plain with alluvial valley extending 12 miles inland to the confluence of the Eel and Van Duzen Rivers and thence upstream as two narrow alluvial valleys. Area: 35 square miles. Coastline: 8 miles.
Water Use	Irrigated pasture divides rural homes, small communities, and dairy and wood industries. Farms, town, and industries have developed well water widely and use some spring water.
Water-bearing Sediments	Conglomerates, sandstones, claystones, and siltstones, all poorly consolidated, form the underlying predominantly continental Carlotta formation. Above this lie poorly consolidated sand, silts, clays, and gravels of the predominantly continental Hookton formation. Both formations outcrop along the borders of the valley. Both produce moderate to large yields of ground water. This water is at least partially confined. Above the Hookton formation, valley alluvium of unconsolidated gravel and sand (fine-grained in the delta) lies as much as 150 feet deep. Its coarser materials contain unconfined ground water. Its storage capacity between depths of 10 to 40 feet approaches 79,000 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	The northwest structural trend continues offshore. The Eel Submarine Canyon, heading in 240 feet of water about seven miles offshore, entrenches the continental shelf and may incise the water-bearing sediments if these extend seaward, as they probably do. Onshore, their base lies several hundred feet below sea level.
Sea-water Intrusion	Sea-water intrusion has been apparent in the coastal part of this valley since 1950. The intruded area seems to coincide with the zone of tidal influence near the ocean, probably because of the highly pervious nature of the Eel River bed that allows ocean water in the tidal zone to percolate into the alluvial materials in this area. The 1952 and 1972 intruded areas are about the same size. The pattern of ground water levels in the past 20 years has changed very little, which tends to stabilize the area of encroachment. The deeper confined aquifers in the Carlotta or Hookton formations do not appear to have been degraded. As long as ground water withdrawals do not change hydrologic conditions, the area of coastal degradation will remain static.

Table 16. MINERAL ANALYSES, BASIN 13, EEL RIVER VALLEY

Item	Surface Water Station	Water Wells, by Owner							
	Eel River at Scotia	Russ Connick Co. of Ferndale	P. C. Lorenzen of Ferndale	Floyd Wilson of Loleta	Foremost Dairy	Ray Tedson	F. E. Tanfran	Joe Taste of Ferndale	A. Ghidinelli
Base and Meridian	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt	Humboldt
Location Number	2N/1E-31	3N/2W-32Q1	3N/2W-35M1	3N/1W-5 K1	3N/1W-18A1	3N/1W-30N1	3N/1W-31J1	2N/1W-4D1	2N/1W-7F1
Date Sampled	5-12-70	9-9-69	7-23-70	6-23-70	9-9-69	9-9-69	9-9-69	6-27-68	6-27-68
Analysis by	DWR *	DWR	DWR	DWR	DWR	DWR	DWR	DWR	DWR
Well Use	-	Irrigation	Irrigation	Domestic, Irrigation	Industrial	Irrigation	Irrigation	Irrigation	Irrigation
Well Depth, in feet	-	268	47	170	165	48	38	48	154
Character	$CaHCO_3$								
Temperature (°F)	58	57	56	56	63	58	58	59	55
EC (Micromhos @ 25° C)	228	901	766	147	418	540	5,630	592	484
pH	8.2	5.9	7.1	6.3	7.6	7.3	7.0	8.5	8.4
Percent Sodium		55	45	43	19	8	28	6	13
CONSTITUENTS, in parts per million									
Total Dissolved Solids	133	538	425	99	214	282	3,900	302	244
Hardness as $CaCO_3$									
Total	101	172	209	39	184	274	2,030	288	206
Noncarbonate	4	169			0	38	1,880	39	50
Aluminum	0.00								
Arsenic		0.00			0.00				
Beryllium	0.00								
Bicarbonate: HCO_3	118	3	308	53	227	288	183	294	186
Bismuth	0.00								
Boron	0.07	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Cadmium	0.00	0.00			0.02				
Calcium	27	25	30	6.8	25	64	274	78	33
Carbonate: CO_3	0.0	0	0	0	0	0	0	5	2
Chloride	3.6	271	75	14	14	14	1,820	8.6	23
Chromium	0.00								
Cobalt	0.00								
Copper	0.00	0.00			0.00				
Fluoride	0.1								
Gallium	0.01								
Germanium	0.00								
Iron	0.01	0.03			0.08				
Lead	0.00	0.00			0.00				
Magnesium	8.1	27	32	5.4	30	28	328	23	30
Manganese	0.00				0.00				
Molybdenum	0.00								
Nickel	0.00								
Nitrate: NO_3	0.0	0.0	5.2	0.0	5.1	16	2.9	18	0.1
Potassium	1.1	3.0	12	1.1	2.1	1.9	9.6	3.1	2.3
Selenium		0.00			0.00				
Silica: SiO_2	9.9								
Sodium	6.5	100	85	11	20	11	373	8.9	15
Sulfate: SO_4	19	0.0	34	2.3	20	32	139	35	53
Titanium	0.00								
Vanadium	0.00								
Zinc	0.01	0.01			0.01				

* California Department of Water Resources

Humboldt County

FLEENER CREEK BASIN - BASIN 14
BEAR RIVER BASIN - BASIN 15
SINGLEY CREEK TERRACE - BASIN 16
DAVIS CREEK TERRACE - BASIN 17
MATTOLE RIVER BASIN - BASIN 18
BIG FLAT CREEK BASIN - BASIN 19

Location	Extends along Cape Mendocino coast from 24 to 58 miles south of Eureka.
Bibliography	Items 1, 4, 14, 19. Page 44.
Description	This precipitous coast is dissected by 16 streams, four of which contain alluvium-filled valleys and two of which contain small, dune-covered marine terraces at their mouths. Combined area of the six basins: 14.5 square miles. Combined coastline: 7 miles.
Water Use	Streams and springs provide most water for homes, scattered communities in Mattole River Valley, lumbering operations, and grazing cattle and sheep. Wells supply some homes in Mattole River Valley.
Water-bearing Sediments	The bedrock outcropping along most of the coast is composed of deformed marine sediments and, where weathered and jointed, provides limited amounts of ground water. The lower reaches of Fleener and Big Flat Creeks and Bear and Mattole Rivers contain partially-filled alluvial valleys whose hydrologic conditions remain unknown because ground water development is so slight. Marine terraces, rare in this area, form ground water basins at Singley and Davis Creeks. Alluvium and dunes partially cover these terraces.
Ground Water Barriers	None known.
Offshore Geology	Although several submarine canyons entrench the continental shelf along this coast, only the Mattole Canyon lies near a ground water basin. It opens in about 120 feet of water and within a mile of the Mattole River mouth. It might possibly incise water-bearing sediments of that basin.
Sea-water Intrusion	No information available as of 1970-71. Fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 17. MINERAL ANALYSES, BASINS 14, 15, 16, 17, 18, and 19, FLEENER CREEK, BEAR RIVER, SINGLEY CREEK, DAVIS CREEK TERRACE, AND BIG FLAT CREEK

Item	Surface Water Stations				
	Fleener Creek	Bear River near Capetown	Singley Creek	Davis Creek	Mattole River near Portola
Base and Meridian		Humboldt			Humboldt
Location Number		1N/3W-13			2S/2W-11
Date Sampled		5-12-70			5-12-70
Analysis by		DWR*			DWR
Character	$NaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$
Total Dissolved Solids	Moderate	Low	Low	Low	Low
Chlorides	Low	Low	Low	Low	Low
Temperature (°F)		56			58
EC (Micromhos @ 25° C)		237			198
pH		8.0			8.1
CONSTITUENTS, in parts per million					
Total Dissolved Solids		163			120
Hardness as $CaCO_3$					
Total		100			84
Noncarbonate		27			13
Bicarbonate: HCO_3		89			87
Boron		0.2			0.1
Calcium		32			26
Carbonate: CO_3		0.0			0.0
Chloride		7.8			5.7
Magnesium		4.9			4.6
Nitrate: NO_3		0.2			0.1
Potassium		1.1			1.0
Sodium		7.8			7.9
Sulfate: SO_4		34			20

*California Department of Water Resources

MENDOCINO COUNTY

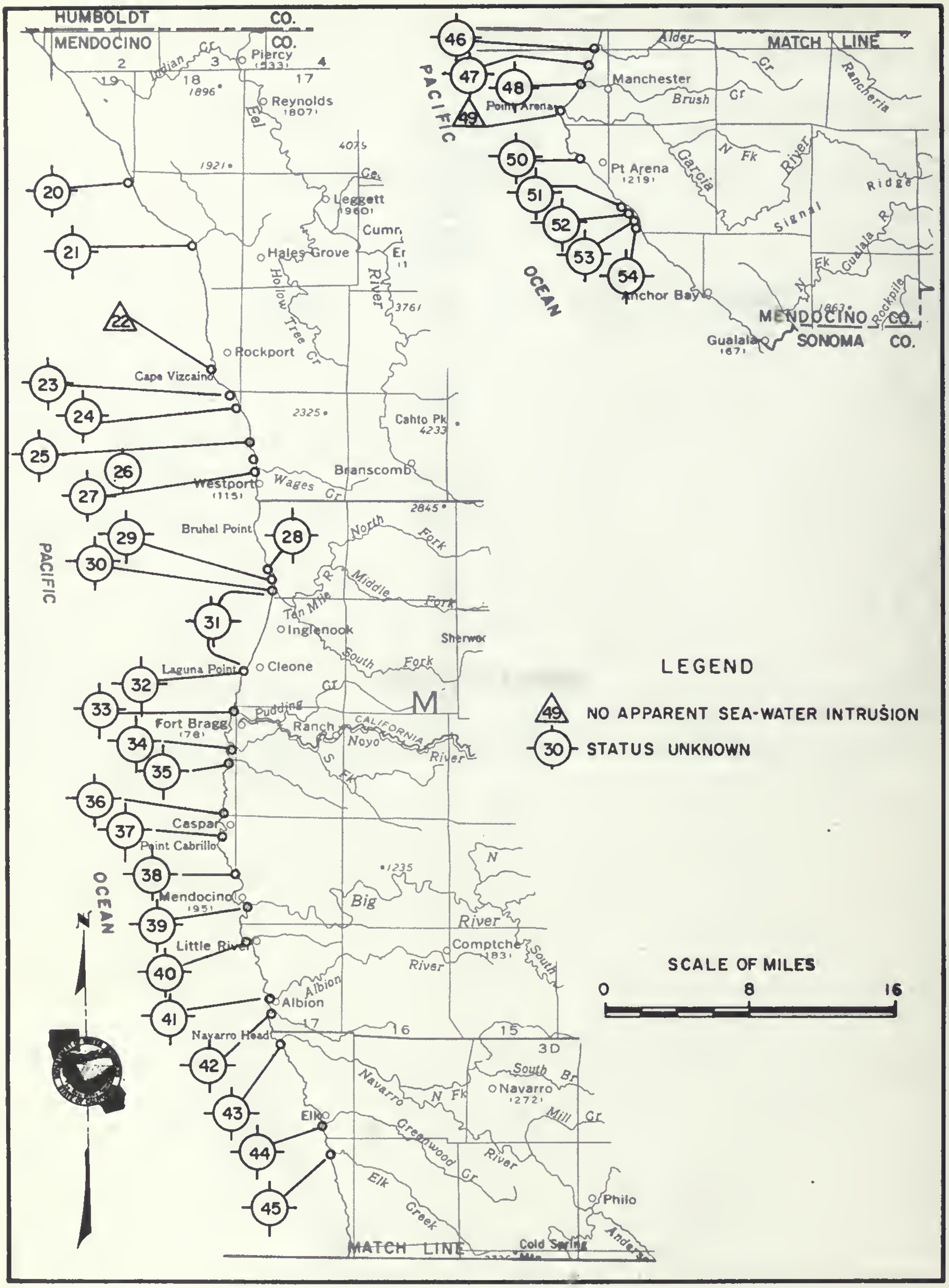

Figure 14. STATUS OF SEA-WATER INTRUSION,
MENDOCINO COUNTY
1970-1971

MENDOCINO COUNTY

The 35 identified ground water basins in coastal Mendocino County lie in valley-fill alluvium. They cover about 17 square miles and are open to the ocean along about 6 miles of coastline. Four valleys range from 2 to 5 square miles; the remainder each cover less than one square mile.

More ground water is available in numerous shallow marine terraces that cover about 55 square miles along the entire central and southern coastline of the county. These terraces have not been identified by name and number. They overlie bedrock and, because they occur above sea level, are not subject to sea-water intrusion.

Ground water storage capacities of each valley and marine terrace have not been estimated, although the Mendocino County Soil Conservation District estimated in 1968 that all valley-fill areas and marine terrace deposits store about 159,500 acre-feet of usable ground water. Offshore aquifers probably store little or no fresh water.

Limited quantities of water for domestic use may be obtainable from older consolidated Cretaceous sedimentary rocks and a limited area of early Tertiary sedimentary rocks south of Point Arena where weathering, jointing, and fracturing have created some secondary porosity and permeability. These areas were excluded from this inventory.

Data collected and evaluated for this inventory indicate that the status of sea-water intrusion in Mendocino County has not changed since the 1954-55 inventory.

Table 18. STATUS OF SEA-WATER INTRUSION, MENDOCINO COUNTY

Basin No.	Basin Name	1953-55	1970-71	Basin No.	Basin Name	1953-55	1970-71
20	Jackass Creek	Status unknown	Status unknown	38	Russian Gulch	Status unknown	Status unknown
21	Usal Creek	Status unknown	Status unknown	39	Big River	Status unknown	Status unknown
22	Cottoneva Creek	No apparent sea-water intrusion	No change	40	Little River	Status unknown	Status unknown
				41	Albion River	Status unknown	Status unknown
23	Hardy Creek	Status unknown	Status unknown	42	Salmon Creek	Status unknown	Status unknown
24	Juan Creek	Status unknown	Status unknown	43	Navarro River	Status unknown	Status unknown
25	Howard Creek	Status unknown	Status unknown	44	Greenwood Creek	Status unknown	Status unknown
26	De Haven Creek	Status unknown	Status unknown	45	Elk Creek	Status unknown	Status unknown
27	Wages Creek	Status unknown	Status unknown	46	Alder Creek	Status unknown	Status unknown
28	Abalobadiah Creek	Status unknown	Status unknown	47	Starmella Ranch	Status unknown	Status unknown
29	Seaside Creek	Status unknown	Status unknown	48	Brush Creek	Status unknown	Status unknown
30	Ten Mile River	Status unknown	Status unknown	49	Garcia River	No apparent sea-water intrusion	No change
31	Little Valley	Status unknown	Status unknown				
32	Mill Creek	Status unknown	Status unknown	50	Point Arena Creek	Status unknown	Status unknown
33	Pudding Creek	Status unknown	Status unknown	51	Mate Creek	Status unknown	Status unknown
34	Noyo River	Status unknown	Status unknown	52	Ross Creek	Status unknown	Status unknown
35	Hare River	Status unknown	Status unknown	53	Gallaway Creek	Status unknown	Status unknown
36	Jug Handle Creek	Status unknown	Status unknown	54	Schooner Gulch	Status unknown	Status unknown
37	Caspar Creek	Status unknown	Status unknown				

BIBLIOGRAPHY

Mendocino County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, Ukiah Sheet. 1960.

2. Geologic Map of California, Santa Rosa Sheet. 1963.

California Department of Water Resources

3. Bulletin No. 62, Recommended Water Well Construction and Sealing Standards, Mendocino County. November 1958. Pp. 83-95

4. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23.

5. Status of Sea-Water Intrusion. December 1960. Pp. 19-41. (Unpublished; drafted as Appendix A of Bulletin No. 63.)

6. Bulletin No. 94-10, Land and Water Use in Mendocino Coast Hydrographic Unit. March 1964. 122 pages.

7. Bulletin No. 130, Hydrologic Data; Volume III, Appendixes C, D, and E. 1963 through 1971.

8. Bulletin No. 142-1, Water Resources and Future Water Requirements in the North Coastal Hydrographic Area; Volume I, Southern Portion. Preliminary edition. April 1965. 450 pages.

9. Bulletin No. 160-70, Water for California, the California Water Plan: Outlook in 1970. December 1970. 179 pages.

10. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

11. Geologic Conditions and the Occurrence and Nature of Ground Water in Mendocino Coastal Hydrographic Unit. Office Report. 1963. 14 pages.

Mendocino County Soil Conservation District

12. Comprehensive Soil and Water Plan for Development of Water, Agriculture, Recreation Communities; Mendocino County Soil and Conservation District, California. September 1968. Appendix C, pp. 1-24; Appendix E, pp. 10-36.

JACKASS CREEK BASIN	BASIN 20	DE HAVEN CREEK BASIN	BASIN 26
USAL CREEK BASIN	BASIN 21	WAGES CREEK BASIN	BASIN 27
COTTONEVA CREEK BASIN	BASIN 22	ABALOBADIAH CREEK BASIN	BASIN 28
HARDY CREEK BASIN	BASIN 23	SEASIDE CREEK BASIN	BASIN 29
JUAN CREEK BASIN	BASIN 24	TEN MILE RIVER BASIN	BASIN 30
HOWARD CREEK BASIN	BASIN 25		

Location — Extends south 34 miles from the Humboldt-Mendocino County line to Ten Mile River.

Bibliography — Items 1, 3, 11, 12. Page 60.

Description — Eleven small alluvium-filled valleys and some thin marine terraces. Combined area of the valleys: 3.5 square miles. Combined coastline of the valleys: 9,800 feet. Combined area of the terraces: 2 square miles.

Water Use — Streams and springs provide most of the water for grazing sheep and cattle, for lumber mills, and for homes and small towns (Rockport, Westport) scattered upon the marine terraces.

Water-bearing Sediments — Partially-filled alluvial valleys along lower reaches of the eleven streams contain ground water. Their estimated combined storage capacity is 14,000 acre-feet. Their average thickness (above sea level) is 50 feet. Their total thickness, together with their general hydrologic condition, remains unknown because they have been pierced by very few wells. Wells are more common, but not abundant, elsewhere. Most tap either the weathered, jointed bedrock of deformed and consolidated marine sediments, or else the thin, overlying, dissected marine terraces. The estimated storage capacity of these terrace deposits is 2,500 acre-feet; their saturated thickness is 25 feet.

Ground Water Barriers — None known.

Offshore Geology — No information available.

Sea-water Intrusion — No evidence exists of sea-water intrusion in Basin 22 as of 1970-71 and no information is available for the remaining ten basins. Fresh-water inflow through the alluvial valleys probably maintains a seaward hydraulic gradient. Sea water poses no threat to the marine terraces along the coast because the base of the terraces does not extend below sea level.

Table 19. MINERAL ANALYSES, BASINS 20, 21, 22, 24, 26, 27, 28, 29 AND 30, JACKASS, USAL, COTTONEVA, JUAN, DE HAVEN, WAGES, ABALOBADIAH, SEASIDE CREEKS AND TEN MILE RIVER

Item	Surface Water Stations								
	Jackass Creek	Usal Creek	Cottoneva Creek	Juan Creek	De Haven Creek	Wages Creek	Abalobadiah Creek	Seaside Creek	Ten Mile River
Character	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaNaHCO_3$	$NaHCO_3$
Total Dissolved Solids	Low	Low	Low	Low	Low	Low	Low	Low	Low
Chlorides	Low	Low	Low	Low	Low	Low	Low	Low	Low

Table 20. MINERAL ANALYSES, BASINS 34, 39, AND MARINE TERRACES, MENDOCINO COUNTY

Item	Surface Water Stations		Water Wella, by Owner					
	Basin 34	Baain 39			Marine Terraces			
	Noyo River near Fort Bragg	Big River near Mouth	Arthur Hantala of Cleone	William Green of Fort Bragg	Fort Bragg	Redwood Elementary School of Fort Bragg	John F. Reese of Mendocino	John Lamplmayr of Mendocino
Baae and Meridian	Mt. Diablo	Mt. Diablo	Mt. Diablo	Mt. Diablo	Mt. Diablo	Mt. Diablo	Mt. Diablo	Mt. Diablo
Location Number	F8 3100.00	F8 2720.00	19N/17W-20N1	19N/17W-30G1	19N/17W-30Q1	18N/17W-7K1	17N/17W-30F1	17N/17W-30M1
Date Sampled	11-5-69	5-14-70	5-20-70	5-20-70	5-20-70	5-20-70	9-11-69	9-11-68
Analysis by	DWR*	DWR	DWR	DWR	DWR	DWR	DWR	DWR
Well Use	-	-	Domestic	Domestic	Domestic	Irrigation	Domestic	Domestic
Well Depth, in feet	-	-	15	35	23	12	60	18
Temperature (°F)	55	57	58	58	57	60	63	
EC (Micromhoa @ 25° C)	163	190	163	296	386	157	700	373
pH	7.6	7.6	7.4	6.9	8.0	6.9	6.8	7.7
Percent Sodium			52	65	75	62	47	47
CONSTITUENTS, in parts per million								
Total Disaolved Solids	163	134	99	172	239	86	386	214
Hardness aa $CaCO_3$								
Total	57	74	33	44	40	26	165	141
Noncarbonate	-	0	0	23	0	0	77	34
Arsenic							0.00	
Bicarbonate: HCO_3	76	9.8	41	26	139	36	29	53
Boron	0.2		0.4	0.3	0.5	0.3	0.0	0.1
Cadmium							0.00	
Calcium	-	20	7.2	6.6	7.5	4.3	33	12
Carbonate: CO_3	0.0		0	0	0	0	0	0
Chloride	9.4	7.0	23	60	49	25	169	46
Copper							0.03	
Iron							0.01	
Lead							0.00	
Magneaium	-	5.8	3.6	6.7	5.2	3.8	20	11
Manganese							0.02	
Nitrate: NO_3	-	0.1	1.0	11	0.1	0.0	40	16
Potasaium	-	0.9	1.8	0.8	6.8	1.0	2.1	5.2
Selenium							0.00	
Sodium	11	11	18	39	67	20	68	34
Sulfate: SO_4	-	6.6	5.3	14	7.2	3.0	18	31
Zinc							0.08	

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Mendocino County

LITTLE VALLEY AREA	BASIN 31	CASPAR CREEK BASIN	BASIN 37
MILL CREEK BASIN	BASIN 32	RUSSIAN GULCH BASIN	BASIN 38
PUDDING CREEK BASIN	BASIN 33	BIG RIVER BASIN	BASIN 39
NOYO RIVER BASIN	BASIN 34	LITTLE RIVER BASIN	BASIN 40
HARE CREEK BASIN	BASIN 35	ALBION RIVER BASIN	BASIN 41
JUG HANDLE CREEK BASIN	BASIN 36	SALMON CREEK BASIN	BASIN 42

Location — Extends south 24 miles from Ten Mile River to Salmon Creek.

Bibliography — Items 1, 3, 11, and 12. Page 60.

Description — An extensive coastal marine terrace area of low relief and 12 small alluvium-filled valleys. Combined area of valleys: 6.4 square miles. Combined coastline of valleys: 7,650 feet. Combined area of all terraces: 33 square miles.

Water Use — Streams, springs, and shallow wells provide water for grazing sheep and cattle, for lumber mills, for several state parks, and for homes and small towns (Fort Bragg, Noyo, Caspar, Mendocino, Little River) scattered upon the marine terraces.

Water-bearing Sediment — Marine terraces with a thin layer of water-bearing materials are incised by the small, alluvium-filled valleys, and cover most of the deformed, consolidated marine sediments which comprise the bedrock. Weathered and fractured, this bedrock contains limited amounts of ground water. The estimated storage capacity of the terrace deposits is 72,000 acre-feet; their saturated thickness is 40 feet. They supply most of the ground water used. In the Little Valley Area, a dune overlies the terraces and forms one large basin. The estimated combined storage capacity of the valleys is 24,500 acre-feet. Their average thickness (above sea level) is 50 feet. Their total thickness, together with their physical characteristics, remains unknown.

Ground Water Barriers — None known.

Offshore Geology — No information available.

Sea-water Intrusion — No information is available as of 1970-71. Fresh-water inflow through the valleys probably maintains a seaward hydraulic gradient. Ground water development in these valleys is minimal. Sea water poses no threat to the marine terraces along the coast because the base of the water-bearing materials on the terraces does not extend below sea level.

NAVARRO RIVER BASIN - BASIN 43

Location	18 miles south of Fort Bragg.
Bibliography	Items 1, 3, 11, and 12. Page 60.
Description	Alluvium-filled valley. Area: 1.3 square miles. Coastline: 1,200 feet.
Water Use	Streams provide water for grazing sheep and cattle and for lumber mills. Ground water not developed.
Water-bearing Sediments	Unconsolidated alluvium. Thickness and physical characteristics unknown.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available as of 1970-71. Fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 21. MINERAL ANALYSES, BASIN 43, NAVARRO RIVER

Item	Surface Water Station: Navarro River near Navarro
Base and Meridian	Mt. Diablo
Location Number	8b
Date Sampled	5-14-70
Analysis by	DWR*
Character	$CaHCO_3$
Temperature (°F)	58
EC (Micromhos @ 25° C)	250
pH	7.7
CONSTITUENTS, in parts per million	
Total Dissolved Solids	144
Hardness as $CaCO_3$	
Total	105
Noncarbonate	0
Bicarbonate: HCO_3	133
Boron	0.4
Calcium	26
Carbonate: CO_3	0.0
Chloride	8.1
Magnesium	9.7
Nitrate: NO_3	0.1
Potassium	0.9
Sodium	12
Sulfate: SO_4	10

* California Department of Water Resources

Mendocino County

GREENWOOD CREEK BASIN	BASIN 44	POINT ARENA CREEK BASIN	BASIN 50
ELK CREEK BASIN	BASIN 45	MATE CREEK BASIN	BASIN 51
ALDER CREEK BASIN	BASIN 46	ROSS CREEK BASIN	BASIN 52
STARAMELLA RANCH BASIN	BASIN 47	GALLAWAY CREEK BASIN	BASIN 53
BRUSH CREEK BASIN	BASIN 48	SCHOONER GULCH BASIN	BASIN 54
GARCIA RIVER BASIN	BASIN 49		

Location — Extends south 32 miles from Greenwood Creek to Gualala River.

Description — Eleven small alluvium-filled valleys dissect low, marine terraces which extend inland as much as five miles. Combined area of the valleys: 6.0 square miles. Combined valley coastline: 12,800 feet. Combined area of the terraces: 20 square miles.

Bibliography — Items 1, 2, 3, 11, 12. Page 60.

Water Use — Streams and springs provide most of the water for grazing sheep and cattle, for lumber mills, for farms, and for homes and small towns (Point Arena, Manchester, Elk) scattered on the marine terraces. Wells are few.

Water-bearing Sediments — The sand, silt, clay, and gravel of the partially-filled alluvial valleys along lower reaches of the eleven streams--most extensively Brush Creek and Garcia River--contain ground water. These deposits probably do not extend much below sea level. Although the most permeable in the basins, these deposits contain few wells. Their maximum thickness, together with their hydrologic condition, remains unknown.

Coastal dunes extend south from Alder Creek to Garcia River. South from Garcia River, cliffs, sometimes 50 feet high, characterize the coastline. Consolidated marine sediments, weathered and jointed, compose the bedrock. Above this lie thin marine terraces, dissected by the streams. Both bedrock and terraces contain some ground water. Most of the wells in the area tap this water. With an assumed average saturated thickness of 30 feet, the estimated usable storage capacity of the alluvial and terrace deposits combined is 51,000 acre-feet.

Ground Water Barriers — The San Andreas fault crosses Basin 46 near the coast and Basins 47 and 48 inland. Whether this fault blocks ground water movement in these basins is unknown. Information relating to ground water barriers in the remaining basins is unavailable.

Offshore Geology — No information available.

Sea-water Intrusion — No evidence of sea-water intrusion existed in Basin 49 as of 1970-71. No information is available for the remaining ten basins. Sea water presently poses no threat to these basins because most wells tap the marine terraces and do not extend below sea level. Fresh-water inflow through the alluvial valleys probably maintains a seaward hydraulic gradient.

Table 22. MINERAL ANALYSES, BASINS 44, 45, 46, 48, 49, 51 and 54, GREENWOOD CREEK, ELK CREEK, ALDER CREEK, BRUSH CREEK, GARCIA RIVER, MATE CREEK, AND SCHOONER GULCH, MENDOCINO COUNTY

Item	Surface Water Stations							Ground Water
	Basin 44	Basin 45	Basin 46	Basin 48	Basin 49	Basin 51	Basin 54	Basin 49
	Greenwood Creek	Elk Creek	Alder Creek	Brush Creek	Garcia River	Mate Creek	Schooner Gulch	Garcia River Basin
Character	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$NaHCO_3$	$NaHCO_3$	$CaHCO_3$	$CaHCO_3$
Total Dissolved Solids	Low	Low	Low	Low	Moderate	Low	Low	Moderate
Chlorides	Low	Low	Low	Low	Low	Low	Low	Low

Table 23. MINERAL ANALYSES, BASIN 50, POINT ARENA CREEK

Item	Surface Water Station	Water Wells, by Owner				
		State of California				
	Point Arena Creek	Department of Parks and Recreation	Division of Highways, Manchester	Division of Forestry	Margaret Bishop of Point Arena	Thomas Hallidy of Point Arena
Location Number		13N/17W-24D1	13N/17W-25H1	12N/17W-12L1	13N/16W-13M1	12N/16W-18K1
Date Sampled		5-19-70	5-18-70	9-11-68	5-19-70	9-10-68
Analysis by	DWR*	DWR	DWR	DWR	DWR	DWR
Well Use	-	Domestic	Domestic	Domestic	Domestic	Domestic
Well Depth, in feet	-	55	17	133	33	10
Character	$NaHCO_3$					
Total Dissolved Solids	Low					
Chlorides	Low					
Temperature (°F)		61	57		69	
EC (Micromhos @ 25° C)		256	410	117	406	413
pH		7.4	7.8	7.1	7.3	7.2
Percent Sodium		69	26	68	58	51
CONSTITUENTS, in parts per million						
Total Dissolved Solids		172	237	60	257	269
Hardness as $CaCO_3$						
Total		34	156	17	76	79
Noncarbonate		18	8	1	34	61
Arsenic				0.00		
Bicarbonate: HCO_3		20	180	20	51	22
Boron		0.3	0.3	0.1	0.3	0.0
Cadmium				0.00		
Calcium		6.8	51	1.6	21	6.7
Carbonate: CO_3		0	0	0	0	0
Chloride		53	28	20	83	55
Copper				0.01		
Iron				0.13		
Lead				0.00		
Magnesium		4.1	7.0	3.2	5.7	15
Manganese				0.00		
Nitrate: NO_3		15	3.8	6.1	14	76
Potassium		1.6	1.1	1.0	2.3	3.9
Selenium				0.00		
Sodium		36	26	18	50	40
Sulfate: SO_4		8.2	17	4.0	12	18
Zinc				0.99		

* California Department of Water Resources

SONOMA COUNTY (COASTAL)

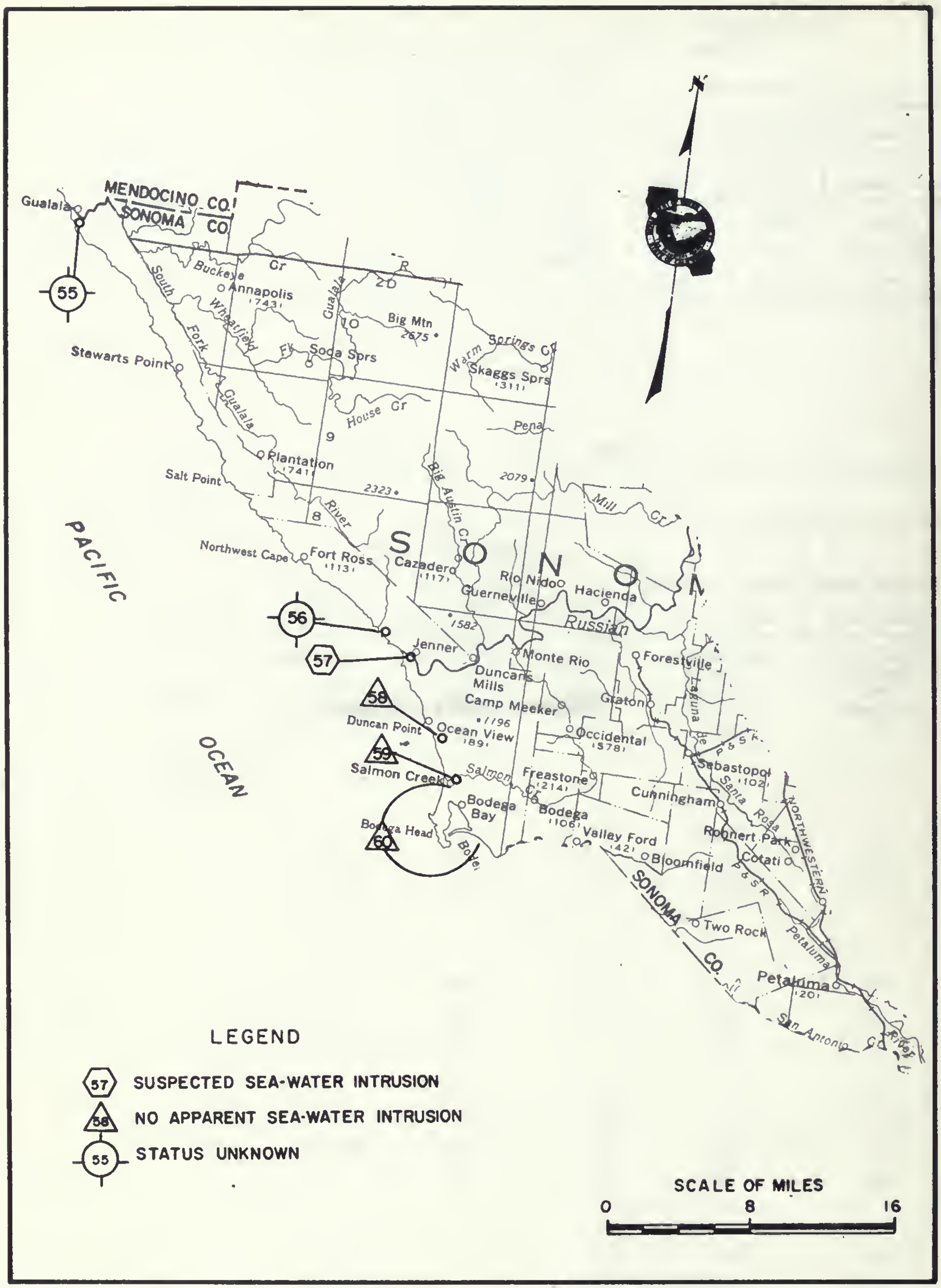


Figure 15. STATUS OF SEA—WATER INTRUSION, SONOMA COUNTY 1970—1971

SONOMA COUNTY (COASTAL)

The six identified ground water basins in coastal Sonoma County lie in valley-fill alluvium. They cover about 15 square miles and are open to the Pacific Ocean along about 5.5 miles of coastline. The largest of these areas are Basin 55, 3.5 square miles; Basin 57, 5 square miles; and Basin 60, 4.5 square miles.

Numerous shallow water-bearing marine terraces along the coast and the Pliocene Ohlson Ranch formation in the northern part of the county contain additional ground water. The terraces and the Ohlson Ranch formation have not been identified for this report. These materials overlie bedrock and, because their base rests above sea level, they are not subject to sea-water intrusion,

Estimates of ground water storage capacity are available for only a few areas. At depths from zero to 50 feet, Basin 55 can store about 12,000 acre-feet. Along its five-mile coastline, Basin 57 can store about 3,500 acre-feet of ground water at depths from zero to 50 feet and about 8,000 acre-feet of ground water at depths from zero to 100 feet. Part of the coastal marine terraces store about 1,100 acre-feet.

With an assumed average thickness of 100 feet, the Pliocene Ohlson formation can store about 35,000 acre-feet. However, the topographic position, discontinuous areal extent, and low well yields of this formation cast considerable doubt on the usability of the ground water it can store.

The potential for fresh water storage in offshore aquifers is unknown but it is probably negligible or nonexistent. The most promising area is located offshore near the coast of Basin 57, where unconsolidated alluvium may be about 300 feet thick.

Limited quantities of water for domestic use may be obtainable from older consolidated Franciscan Group rocks, from Cretaceous sedimentary rocks, and from the limited area of early Tertiary sedimentary rocks in northern coastal Sonoma County, where weathering, jointing, and fracturing have created some secondary porosity and permeability. These areas were excluded from the statewide inventory.

Table 24. STATUS OF SEA-WATER INTRUSION, SONOMA COUNTY (COASTAL)

Basin No.	Basin Name	1953-55	1970-71
55	Gualala River	Status unknown	Status unknown
56	Russian Gulch	Status unknown	Status unknown
57	Russian River	Suspected sea-water intrusion	No change
58	Scotty Creek	Status unknown	No apparent sea-water intrusion
59	Salmon Creek Valley	Status unknown	No apparent sea-water intrusion
60	Bodega Bay	Chlorides exceed 100 100 ppm	No information on area degraded in 1954. No apparent sea water intrusion in remainder of basin

BIBLIOGRAPHY

Sonoma County (Coastal)

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, Santa Rosa Sheet. 1963.

California Department of Water Resources

2. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp.19-23.

3. Status of Sea-Water Intrusion. December 1960. Pp. 41-46. (Unpublished; drafted as Appendix A of Bulletin No. 63)

4. Bulletin No. 94-10, Land and Water Use in Mendocino Coast Hydrographic Unit. March 1964. 122 pages.

5. Bulletin No. 94-11, Land and Water Use in Russian River Hydrographic Unit. November 1964. 212 pages.

6. Bulletin No. 130, Hydrologic Data; Volume III, Appendixes C, D, and E. 1963 through 1971.

7. Bulletin No. 142-1, Water Resources and Future Water Requirements in the North Coastal Hydrographic Area; Volume I, Southern Portion.

8. Bulletin No. 143-4, Russian River Watershed, Water Quality Investigation. May 1968. Pp. 102, 109.

9. Bulletin No. 160-70, Water for California, The California Water Plan: Outlook in 1970. December 1970. 179 pages

10. Office Report: Geologic Conditions and the Occurrence and Nature of Ground Water in Mendocino Coast Hydrographic Unit. 1963. Pp. 12-14

11. Office Report: Geologic Conditions and the Occurrence and Nature of Ground Water in the Russian River Hydrographic Unit. 1963. Pp. 21-25.

12. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

Mendocino County Soil Conservation District

13. Comprehensive Soil and Water Plan for Development of Water, Agriculture, Recreation Communities; Mendocino County Soil and Conservation District, California. September 1968. Appendix C, Pp. 1-24, Appendix E, Pp. 15-16.

U. S. Geological Survey

14. Water Supply Paper 1548, Geology and Ground Water in Russian River Valley Areas and in Round, Laytonville, and Little Lake Valleys, Sonoma and Mendocino Counties, California. 1965. Pp. 23-29.

GUALALA RIVER BASIN - BASIN 55

Location	13 miles southeast of Point Arena; lies partly in Mendocino County.
Bibliography	Items 1, 10, 13. Page 70.
Description	Alluvium-filled valley. Area: 3.5 square miles. Coastline: 3,000 feet.
Water Use	Streams provide water for grazing cattle and for a few homes. Extent of ground water use is unknown.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics. Estimated storage capacity, assuming an average thickness of 50 feet, is 12,000 acre-feet. Between Basins 55 and 56 lie many shallow marine terraces of Pleistocene age, together with the Ohlson Ranch formation of Pliocene age. Because their bases lie above sea level, sea water does not threaten to intrude. The estimated storage capacity of the terraces is 1,100 acre-feet; that of the Ohlson Ranch formation is 35,000 acre-feet. The extent of ground water use is unknown.
Ground Water Barriers	The San Andreas fault crosses this basin about two miles inland. Whether this fault blocks ground water movement is unknown.
Offshore Geology	No information available.
Sea-water Intrusion	No information is available as of 1970-71. Fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 25. MINERAL ANALYSES, BASIN 55, GUALALA RIVER

Item	Surface Water Stations		
	North Fork	Underflow	
Location		11N/15W-26M	10N/14W-16R
Character	$CaHCO_3$		
Total Dissolved Solids (ppm)	132		
Chlorides (ppm)	8	45	20

Sonoma County (Coastal)

RUSSIAN GULCH BASIN - BASIN 56

Location	6 miles southeast of Fort Ross.
Bibliography	Items 1, 10, 13. Page 70.
Description	Alluvium-filled valley extending ½ mile northeast from coast. Area: 0.05 square mile. Coastline: 500 feet.
Water Use	No information available.
Water-bearing Sediments	Unconsolidated alluvium; thickness and physical characteristics remain unknown.
Ground Water Barriers	None known
Offshore Geology	No information available.
Sea-water Intrusion	No information available as of 1970-71. Fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 26. MINERAL ANALYSIS, BASIN 56, RUSSIAN GULCH

Item	Surface Water
Character	$CaHCO_3$
Total Dissolved Solids (ppm)	134
Chlorides (ppm)	12

Sonoma County (Coastal)

RUSSIAN RIVER BASIN - BASIN 57

Location	8 miles southeast of Fort Ross.
Bibliography	Items 1, 8, 14. Page 70.
Description	Alluvium-filled valley extending 10 miles east from coast. Area: 5 square miles. Coastline: 3,500 feet.
Water Use	Streams provide most of the water for grazing cattle, for irrigation, and for the resorts, homesites and campgrounds which lie between Duncan Mills and Hacienda, and near Jenner and Bridge Haven.
Water-bearing Sediments	Well logs show that the thickness of unconsolidated Quaternary alluvium at the mouth of the Russian River exceeds 125 feet. It may exceed 300 feet. From the coast to a point five miles inland, storage capacity is 3,500 acre-feet to depths of 50 feet, and 8,000 acre-feet to depths of 100 feet.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably extends offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water was sampled in the coastal segment of this valley during the summer of 1954 and during 1970. West of Duncan Mills, chloride concentrations in ground water have been 400 times heavier than is normal for ground water. In those years when recharge is low, ground water outflow is correspondingly low, and the intrusion of sea water into the tidal portion of the basin increases.

Table 27. MINERAL ANALYSES, BASIN 57, RUSSIAN RIVER

Item	Surface Water: Russian River above Guerneville	Ground Water						
Location Number		7N/10W-7A		7N/10W-7H		7N/11W-14E1	7N/11W-17K1	7N/11W-20D1
Date Sampled		1970	1960s	1970	1960s	1954	1954	1954
Character	$CaHCO_3$	-	-	-	-	$NaHCO_3$	NaCl	NaCl
Total Dissolved Solids (ppm)	102	-	-	-	-	191	5,400	1,400
Chlorides (ppm)	12	10	220	10	221	14	2,920	744

SCOTTY CREEK BASIN - BASIN 58
SALMON CREEK VALLEY BASIN - BASIN 59

Location — 8 miles south from Jenner to Salmon Creek.

Bibliography — Items 1, 3, 12. Page 70.

Description — Two alluvium-filled valleys incise coastal marine terraces of low relief. Combined area of valleys: 1.7 square miles. Combined coastline of valleys: 700 feet.

Water Use — Springs and some shallow wells supply water for grazing cattle and small farms.

Water-bearing Sediments — Shallow marine terraces (maximum thickness: 75 feet) overlie most of the bedrock. This bedrock is consolidated rock of the Franciscan formation. The thickness and physical characteristics of the valley alluvium remain unknown.

Ground Water Barriers — None known.

Offshore Geology — No information available.

Sea-water Intrusion — No evidence of degraded water in the two alluvial valleys existed as of 1970. Fresh-water inflow through the alluvial valleys probably maintains a seaward hydraulic gradient. Sea water poses no threat to the terraces because they lie above bedrock.

Table 28. MINERAL ANALYSES, BASINS 58 AND 59, SCOTTY CREEK AND SALMON CREEK VALLEY

Item	Basin 58		Basin 59				
	Surface Water	Ground Water	Surface Water	Ground Water			
	Scotty Creek		Salmon Creek				
Location Number	-	6N/11W-3M	-	6N/11W-14Q1	6N/11W-14Q2	6N/11W-22G1	6N/11W-22G2
Date Sampled	-	1970	-	1970	1970	1970	1970
Character	NaCl	-	$MgNaHCO_3$	-	-	-	-
Total Dissolved Solids (ppm)	260	-	81	-	-	-	-
Chlorides (ppm)	111	80	11	60	60	65	65

Sonoma County (Coastal)

BODEGA BAY BASIN - BASIN 60

Location 9 miles southeast of Jenner.

Bibliography Items 1, 3, 12. Page 70.

Description Dunes to the north and the shallow waters of Bodega Bay to the south overlie this alluvium-filled valley. Johnson and Cheney Gulches, also alluvium-filled, enter the Bay from the east. To the south, Doran Sand Spit thrusts westward across the mouth of the Bay. Area: 4.5 square miles. Coastline of dunes to the north: 2.5 miles; coastline of dunes along Doran Sand Spit: 1.5 miles.

Water Use Streams provide water for sheep and cattle grazing on the valley floor, among dunes, and upon adjacent marine terraces. A reservoir on Salmon Creek provides domestic water for the town of Bodega Bay, which stands upon a marine terrace. Shallow wells in the dunes and marine terraces supplement this supply.

Water-bearing Sediments The thickness and physical characteristics of the dunes, unconsolidated alluvium, and marine terraces remain unknown.

Ground Water Barriers Extending along the eastern edge of the basin, the San Andreas fault crosses Johnson and Cheney gulches. Its effect upon ground water movement remains unknown.

Offshore Geology No information available.

Sea-water Intrusion In 1954, degraded ground water, probably from the tidal marshlands, was discovered in one well in the coastal portion of the basin. Samples from this well were not available as of 1971. Sampling from two wells in other coastal portions of the basin indicated that chlorides were less than 100 ppm.

Table 29. MINERAL ANALYSES, BASIN 60, BODEGA BAY

Item	Surface Water	Ground Water				
	Cheney Gulch				Pond	
Location Number	-	6N/11W-22K1	6N/11W-22L1	6N/11W-27Q1	6N/11W-34M	6N/11W-36M
Date Sampled	-	1954	1954	1954	1971	1971
Character	$NaHCO_3$	$NaHCO_3$	NaCl	MgNaCl	-	-
Total Dissolved Solids (ppm)	91	232	179	333	-	-
Chlorides (ppm)	20	59	48	122	90	55
EC (micromhos @ 25° C)	-	-	-	-	49	55

MARIN COUNTY (COASTAL)

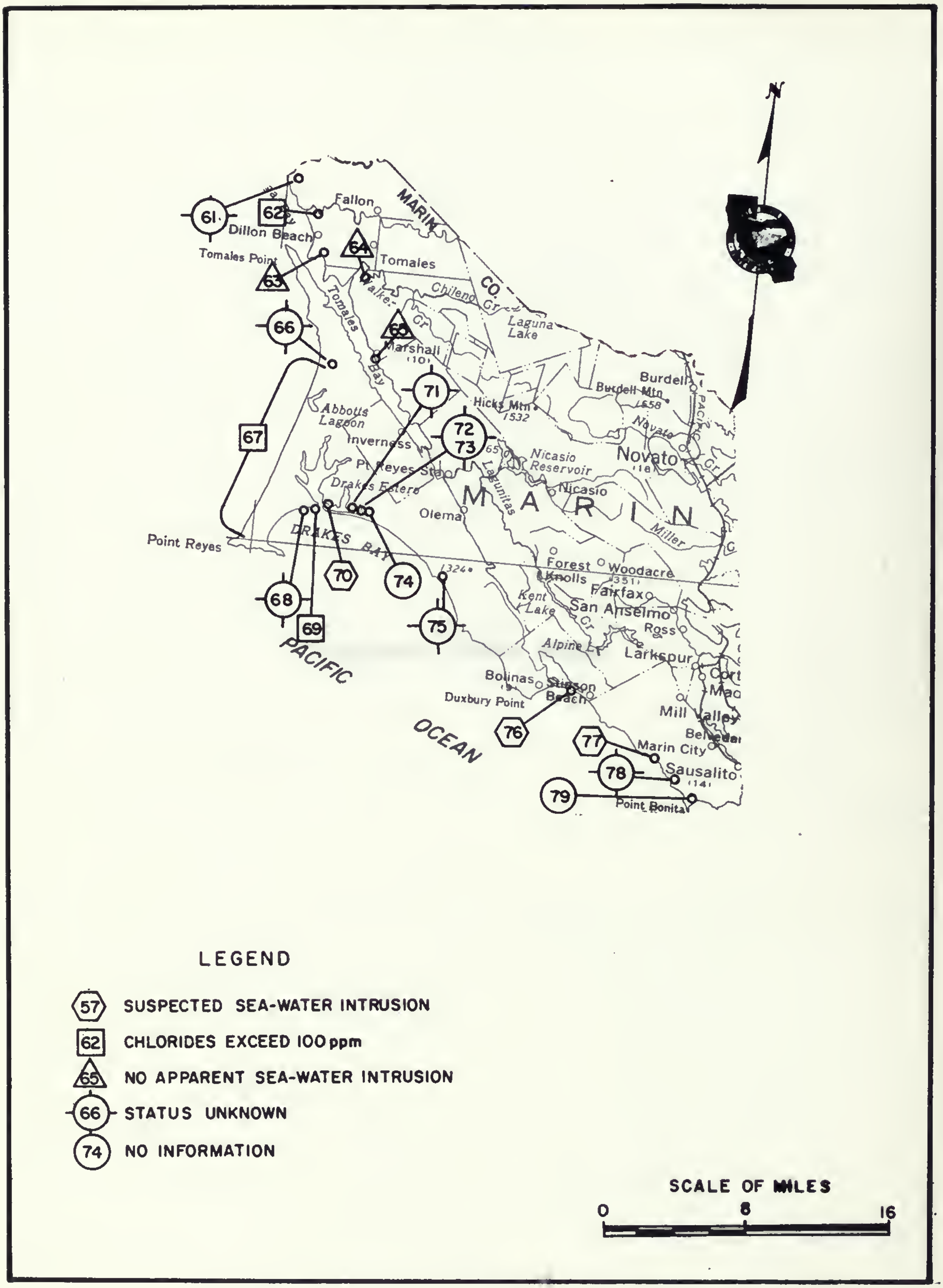


Figure 16. STATUS OF SEA-WATER INTRUSION, MARIN COUNTY 1970-1971

MARIN COUNTY (COASTAL)

The 19 identified ground water basins in coastal Marin County lie in 17 small areas of valley-fill alluvium and two areas of sand dunes. They cover about 31 square miles and are open to the Pacific Ocean along about 19 miles. The largest of these are Basin 61, 5.5 square miles; Basin 62, 7.5 square miles; Basin 65, 4 square miles; and Basin 67, 5 square miles.

Additional ground water is available in several shallow marine terraces along isolated coastal areas and in the Pliocene Merced formation underlying and flanking portions of Basins 61, 62, 64, and 75. In most locations the terraces and the Merced formation lie above sea level and are therefore not subject to sea-water intrusion.

Estimates of ground water storage capacity are not available for individual basins; however, water-bearing material in the northern part of the county from Basin 64 to the boundary with Sonoma County are estimated as: alluvium, 34,000 acre-feet; marine terraces, 2,700 acre-feet; and the Merced formation, 530,000 acre-feet. The potential for fresh water storage in offshore aquifers is unknown but probably is negligible or nonexistent.

Limited quantities of water for domestic use may be obtainable from older consolidated Franciscan formation rocks east of the San Andreas fault and from Mesozoic granitic rocks and Pliocene and Miocene sedimentary rocks on Point Reyes Peninsula west of the San Andreas fault. Weathering, jointing, and fracturing have created some secondary porosity and permeability in these rock units. These areas were excluded from the statewide inventory.

Table 30. STATUS OF SEA-WATER INTRUSION MARIN COUNTY (COASTAL)

Basin No.	Basin Name	1953-55	1970-71
61	Estero Americano	Status unknown	Status unknown
62	Estero de San Antonio	Status unknown	Chlorides exceed 100 ppm
63	Sand Point	Status unknown	No apparent sea-water intrusion
64	Walker Creek	No apparent sea-water intrusion	No change
65	Tomales Bay	No apparent sea-water intrusion	No change
66	Kehoe Creek	Status unknown	Status unknown
67	Point Reyes Sand Dunes	No apparent sea-water intrusion	Chlorides exceed 100 ppm
68	Drakes Bay	Status unknown	Status unknown
69	Point Reyes	Status unknown	Chlorides exceed 100 ppm
70	Drakes Estero	No apparent sea-water intrusion	Suspected sea-water intrusion
71	Estero de Limantour	Status unknown	Status unknown
72	Glenbrook Creek	Status unknown	Status unknown
73	Muddy Hollow	Status unknown	Status unknown
74	Laguna Ranch	No apparent sea-water intrusion	No information
75	Bear Valley	Status unknown	Status unknown
76	Bolinas Lagoon	No apparent sea-water intrusion	Suspected sea-water intrusion
77	Frank Creek	Chlorides exceed 100 ppm	Suspected sea-water intrusion
78	Elk Valley	Status unknown	Status unknown
79	Rodeo Lagoon	No apparent sea-water intrusion	No information

BIBLIOGRAPHY

Coastal Marin County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, San Francisco Sheet. 1961.

2. Geologic Map of California, Santa Rosa Sheet. 1963.

California Department of Water Resources

3. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23.

4. Status of Sea-Water Intrusion. December 1960. Pp. 46-60. (Unpublished; drafted as Appendix A of Bulletin No. 63).

5. Bulletin No. 94-11, Land and Water Use in Russian River Hydrographic Unit. November 1964. 212 pages.

6. Bulletin No. 130, Hydrologic Data; Volume III, Appendixes C, D, and E. 1963 through 1971.

7. Bulletin No. 160-70, Water for California, The California Water Plan: Outlook in 1970. December 1970. 179 pages.

8. Geologic Conditions and the Occurrence and Nature of Ground Water in the Russian River Hydrographic Unit. Office Report. 1963. Pp. 22-24.

9. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

U. S. Geological Survey

10. Open File Report. Hydrologic Reconnaissance of Point Reyes National Seashore Area, California. 1966. 37 pages.

Sonoma County (Coastal)

ESTERO AMERICANO - BASIN 61

Location	3.5 miles southeast of Bodega Bay; lies partly in Sonoma County.
Bibliography	Items 2, 8. Page 80.
Description	Narrow, branching alluvium-filled valley extending east from coast. Area: 5.5 square miles. Coastline: 800 feet.
Water Use	Streams and shallow wells provide water for cattle and sheep grazing in the valley and on adjacent, grass-covered hills, for scattered ranches, and for the towns of Bloomfield and Valley Ford. No wells appear near the coast; inland, some tap the Merced formation.
Water-bearing Sediments	Ground water appears in isolated marine terraces, in unconsolidated alluvium of unknown thickness and physical characteristics, and in the sandstones, conglomerates, shales, and lenses of sand and gravel comprising the Merced formation. Of Pliocene age, this latter formation underlies the alluvium and adjacent rolling hills of the middle and upper portions of the valley. Although the storage capacity of this valley remains unknown, estimated storage capacity for the area south from southern Sonoma County (including this valley) through Basin 64 is: alluvium, 34,000 acre-feet; marine terraces, 2,700 acre-feet; and the Merced formation, 530,000 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available as of 1970. Fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 31. MINERAL ANALYSIS, BASIN 61, ESTERO AMERICANO

Item	Surface Water: Estero Americano Creek
Character	$CaHCO_3$
Total Dissolved Solids (ppm)	106
Chlorides (ppm)	15

Marin County (coastal)

ESTERO DE SAN ANTONIO BASIN - BASIN 62

Location	6 miles southeast of Bodega Bay.
Bibliography	Items 2, 8. Page 80.
Description	Alluvium-filled valley extending east from coast. Area: 7.5 square miles. Coastline: 1,300 feet.
Water Use	Coastal ground water undeveloped. Streams and shallow wells provide water for cattle and sheep grazing the central and upper valley, for ranches dotting the valley and adjacent hills, and for Fallon, Two Rock, and a military installation.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics is underlain by the Merced formation, which also underlies the hills bordering the valley.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water was recognized in the coastal part of this valley as of 1970. Chlorides in wells in this tidal area range from 150 to 200 parts per million.

Table 32. MINERAL ANALYSES, BASIN 62, ESTERO DE SAN ANTONIO

Item	Surface Water	Ground Water	
	Stemple Creek		
Location Number	-	5N/10W-15C	5N/10W-15L
Date Sampled	-	1970	1970
Character	$MgCaHCO_3$	-	-
Total Dissolved Solids (ppm)	84	-	-
Chlorides (ppm)	12	200	140

SAND POINT AREA - BASIN 63
WALKER CREEK BASIN - BASIN 64
TOMALES BAY BASIN - BASIN 65

Location	Extends along Tomales Bay from Dillon Beach 18 miles south to Olema.
Bibliography	Items 2, 4, 9, 10. Page 80.
Description	Basin 63, a large area of dunes, flanks the entrance to Tomales Bay on the northeast. Basin 64, trending northeast, is moderately sized. Basin 65 comprises numerous small, alluvium-filled valleys entering Tomales Bay from the northeast, southeast, and southwest. Combined area: 7.3 square miles. Combined coastline: 8 miles.
Water Use	Shallow wells and springs provide water for Dillon Beach, Tomales, Olema, Point Reyes Station, Inverness, and for cattle and sheep.
Water-bearing Sediments	Alluvium-filled valleys cut a bedrock of granitic intrusives and consolidated Franciscan formation rocks. The water-bearing Merced formation flanks upper Walker Creek (Basin 64). Physical characteristics and thickness of the dunes and the alluvium remain unknown.
Ground Water Barriers	San Andreas fault traverses Tomales Bay. Its effect, if any, on ground water in the valleys of Basins 64 and 65 is unknown.
Offshore Geology	No information available.
Sea-water Intrusion	No evidence of sea-water intrusion or degraded ground water existed as of 1970. Tides in Tomales Bay influence the area but chlorides in ground water remain below 100 parts per million. Fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 33. MINERAL ANALYSES, BASINS 63 AND 64, SAND POINT AREA AND WALKER CREEK

Item	Basin 63			Basin 64			
	Ground Water			Surface Water	Ground Water		
Location Number	5N/10W-28F	5N/10W-28K	5N/10W-28Q	Walker Creek	5N/10W-25R	5N/10W-36M	5N/10W-32N2
Date Sampled	1970	1970	1970	-	1970	1970	1954
Character	-	-	-	$MgHCO_3$	-	-	-
Total Dissolved Solids (ppm)	-	-	-	90	-	-	126
Chlorides (ppm)	60	100	40	14	80	40	28

Table 34. MINERAL ANALYSES, BASIN 65, TOMALES BAY

Item	Olema Creek	Lagunitos Creek	Wells			
Location Number	-	-	3N/9W-7F	4N/10W-14A	4N/10W-36R	3N/9W-9Q
Date Sampled	-	-	1971(Spring)	1970	1970	1970
Character	$NaMgCaHCO_3$	$NaMgCaHCO_3$	-	-	-	-
Total Dissolved Solids (ppm)	70	66	-	-	-	-
Chlorides (ppm)	12	7	38	160	60	50

Item	Wells					
Location Number	3N/9W-16P1	3N/9W-17A1	3N/9W-22L	3N/9W-22M	3N/9W-25K	3N/9W-26H1
Date Sampled	1954	1954	1970	1970	1970	1954
Character	$NaHCO_3$	$MgSO_4$	-	-	-	$NaHCO_3$
Total Dissolved Solids (ppm)	114	376	-	-	-	184
Chlorides (ppm)	28	57	40	40	20	26

Marin County (Coastal)

KEHOE CREEK BASIN - BASIN 66
POINT REYES SAND DUNES AREA - BASIN 67
DRAKES BAY BASIN - BASIN 68
POINT REYES BASIN - BASIN 69

Location	Extends along Point Reyes Peninsula from Kehoe Creek 17 miles south to Drakes Bay.
Bibliography	Items 2, 4, 9, 10. Page 80.
Description	Extensive dunes lie along the length of Basin 67. Basin 66 to the north and Basins 68 and 69 at Drakes Bay to the south are small alluvium-filled valleys. Combined area: 5.6 square miles. Area of Basin 67 dunes: 5 square miles. Combined coastline: 9.5 miles.
Water Use	A few wells provide water for the National Seashore Area of Point Reyes Peninsula, and for the few cattle and sheep that graze the basins.
Water-bearing Sediments	Three small alluvium-filled valleys incise bedrock comprising Pliocene and Miocene marine sediments. In Basin 67, dunes cover the Pliocene sediments. The thickness and physical characteristics of both the alluvium and the dunes remain unknown.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water was recorded in the coastal segment of Basins 67 and 69 as of 1970-71. No information was available for Basins 66 and 68 as of 1970. Fresh-water inflow probably maintains a seaward hydraulic gradient in Basins 66 and 68.

Table 35. MINERAL ANALYSES, BASINS 66, 67, AND 69, KEHOE CREEK, POINT REYES SAND DUNES AND POINT REYES

Item	Basin 66	Basin 67		Basin 69
	Kehoe Creek	Wells		Well
		3N/10W-15K1	3N/10W-28L	2N/10W-10N
Date Sampled	-	1954	1971	1970
Character	NaCl	NaCl	-	-
Total Dissolved Solids (ppm)	128	134	-	-
Chlorides (ppm)	42	44	186	100
EC (Micromhos @ 25° C)	-	-	444	-

DRAKES ESTERO BASIN - BASIN 70

Location — At Drakes Bay.

Bibliography — Items 2, 4, 9. Page 80.

Description — This large, branching valley, almost totally inundated by sea water, extends northward from Drakes Bay. Along its inland edge, remnants of the valley floor lie above sea level. Area: 1 square mile. Coastline length: unknown.

Water Use — Several small wells provide water for homes and for grazing cattle.

Water-bearing Sediments — Unconsolidated alluvium of unknown thickness and physical characteristics.

Ground Water Barriers — None known.

Offshore Geology — No information available.

Sea-water Intrusion — An area of degraded ground water was discovered during 1970-71 near Johnson's Oyster Plant, where pumping is heavy. Existing degraded ground water may result from sea-water intrusion. Elsewhere, though information remains unavailable, fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 36. MINERAL ANALYSES, BASIN 70, DRAKES ESTERO

Item	Creek in Upper Valley	Wells		
		3N/10W-24M1	3N/10W-25K1	3N/10W-26C
Date Sampled	-	1954	1954	1970
Character	NaCl	$CaHCO_3$	$CaHCO_3$	-
Total Dissolved Solids (ppm)	173	449	304	-
Chlorides (ppm)	40	80	41	580

Marin County (Coastal)

ESTERO DE LIMANTOUR BASIN - BASIN 71
GLENBROOK CREEK BASIN - BASIN 72
MUDDY HOLLOW BASIN - BASIN 73
LAGUNA RANCH BASIN - BASIN 74
BEAR VALLEY BASIN - BASIN 75

Location	Extends 6 miles along the coast of Drakes Bay.
Bibliography	Items 1, 2, 4, 9, 10. Page 80.
Description	5 small, alluvium-filled valleys open onto Drakes Bay. From Basin 74, a sand spit curves westward, sheltering the mouths of the creeks entering the Bay from Basins 71 through 74. Area: 1.4 square miles. Coastline: 3,600 feet.
Water Use	A few scattered wells and springs supply water to the few homes and small herds of cattle found in the region.
Water-bearing Sediments	Some ground water occurs in the alluvium of the five valleys, which incise Pliocene and Miocene marine sediments comprising the bedrock. Some ground water may occur in the sand bar which lies off the mouth of the valleys.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information was available as of 1970. Fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 37. MINERAL ANALYSES, BASIN 74, LAGUNA RANCH

Item	Laguna Ranch Creek	Wells	
		2N/9W-5J1	2N/9W-8F2
Date Sampled	-	1954	1954
Character	$CaHCO_3$	$NaHCO_3$	$NaHCO_3$
Total Dissolved Solids (ppm)	264	221	391
Chlorides (ppm	40	36	46

BOLINAS LAGOON BASIN - BASIN 76

Location	At Bolinas Bay, about 14 miles northwest of San Francisco.
Bibliography	Items 1, 4, 9. Page 80.
Description	This valley, traversed longitudinally by the San Andreas fault, almost totally inundated by sea water, and partially filled by alluvium, drains many small, alluvium-filled valleys. A sand spit, 500 feet wide and 2.5 miles long, separates this valley from Bolinas Bay. Area: 1 square mile. Coastline length is unknown.
Water Use	Most of the alluvial valleys have some residential development and stock grazing. Some surface water is used for stock watering. Shallow wells in Paradise Valley and Stinson Beach supply domestic and irrigation needs.
Water-bearing Sediments	The thickness and physical characteristics of the dunes and unconsolidated alluvium which overlie the Merced formation (Pliocene age) are unknown.
Ground Water Barriers	The effect of the San Andreas fault upon ground water movement remains unknown.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water in which chlorides exceed 100 parts per million was detected in 1970 in a single well lying 75 feet inland from the lagoon. Fresh-water inflow probably maintains a seaward hydraulic gradient along the eastern shore of the lagoon, where sea-water intrusion is not evident.

Table 38. MINERAL ANALYSES, BASIN 76, BOLINAS LAGOON

Item	Pine Gulch Creek	Creek on east side	Ground Water					
Location Number			1N/7W-20M	1N/7W-29R1	1N/8W-13Q	18/8W-14A1	1N/8W-24M1	1N/8W-24N1
Date Sampled	-	-	1970	1954	1970	1954	1954	-
Character	$NaHCO_3$	$CaHCO_3$	-	$MgHCO_3$	-	$MgHCO_3$	$MgHCO_3$	$MgHCO_3$
Total Dissolved Solids (ppm)	201	214	-	180	-	181	479	266
Chlorides (ppm)	28	30	40	27	1,100	27	68	34

Marin County (Coastal)

FRANK CREEK BASIN - BASIN 77

Location	5 miles west of Sausalito.
Bibliography	Items 1, 4, 9. Page 80.
Description	Alluvium-filled valley extending northeast from coast. Area: 0.4 square mile. Coastline: 1,000 feet.
Water Use	A few shallow wells supply water for homes. Several small diversions from Frank Creek irrigate truck crops and pasture in the middle and upper parts of the valley. The coastal part of the valley is a private beach resort.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water was sampled in the coastal segment in 1970. Chlorides in this area have increased from 515 ppm in 1954 to 720 ppm in 1970. This degradation may be related to intrusion of sea water. With increased pumping in the upper valley, the salinity wedge might move inland.

Table 39. MINERAL ANALYSES, BASIN 77, FRANK CREEK

Item	Frank Creek	Ground Water			
Location Number		1S/6W-7D	1S/6W-7D	1S/6W-7D2	1S/7W-1G
Date Sampled	-	1970	-	1954	1970
Character	$MgHCO_3$	-	-	$MgHCO_3$-NaCl	-
Total Dissolved Solids (ppm)	166	-	-	1,090	-
Chlorides (ppm)	28	720	2,862	515	60

ELK VALLEY BASIN - BASIN 78
RODEO LAGOON BASIN - BASIN 79

Location	4 miles west of Sausalito.
Bibliography	Items 1, 4, 9. Page 80.
Description	Two small alluvium-filled valleys extending northeast from coast. Combined area: 1.1 square miles. Coastline: 1,600 feet.
Water Use	Except in a military reservation along the coast at Rodeo Lagoon, water is used primarily to maintain herds of cattle.
Water-bearing Sediments	The valley alluvium is of unknown thickness and physical characteristics. The valleys incise consolidated rocks of the Franciscan formation.
Ground Water Barriers	None known.
Sea-water Intrusion	No information was available as of 1970. Fresh-water inflow probably maintains a seaward hydraulic gradient.

Table 40. MINERAL ANALYSES, BASINS 78 AND 79, ELK VALLEY AND RODEO LAGOON

Item	Basin 78	Basin 79	
	Elk Creek	Rodeo Creek	Well 1S/6W-22D1
Date Sampled	-	-	1954
Character	$MgCaHCO_3$	$NaHCO_3$	NaCl
Total Dissolved Solids (ppm)	615	170	56
Chlorides (ppm)	102	42	19

CHAPTER IV

SAN FRANCISCO BAY AREA BASINS

Sonoma County (Bay Shoreline)
Marin County (Bay Shoreline)
Solano County
Napa County
Sacramento County
San Joaquin County
Contra Costa County
Alameda County
Santa Clara County
San Mateo County (Bay Shoreline)
San Francisco County (Bay Shoreline)

Figure 17. STATUS OF SEA-WATER INTRUSION, SAN FRANCISCO BAY AREA COUNTIES 1970-1971

SAN FRANCISCO BAY AREA

The 33 identified ground water basins that occur in the San Francisco Bay Area lie in 11 counties whose boundaries touch San Francisco Bay, Richardson Bay, San Pablo Bay, Suisun Bay, and the delta of the Sacramento-San Joaquin Rivers. These counties are Marin, Sonoma, Napa, Solano, Sacramento, San Joaquin, Contra Costa, Alameda, Santa Clara, San Mateo, and San Francisco. Four of these--Marin, Sonoma, San Francisco, and San Mateo--are also bound partially by the Pacific Ocean and the coastal ground water basins they contain are discussed elsewhere in this report under the county titles.

The Bay Area ground water basins, which lie in valley-fill alluvium, cover about 1,540 square miles and are open to the Bay shoreline for about 155 miles. The largest of these are Basin 93, 625 square miles; Basin 105, 458 square miles; Basin 92, 170 square miles; Basin 94, 50 square miles; Basin 87, 45 square miles; and Basin 86, 25 square miles.

Flanking and underlying several of the larger alluvium-filled valleys are older Plio-Pleistocene water-bearing formations that contain varying amounts of ground water. These materials include the Merced and Petaluma formations and Sonoma volcanics associated with Basin 87; the Huichica and Glen Ellen formations and Sonoma volcanics of Basin 88; the Sonoma volcanics of Basin 92; the Montezuma formation of Basin 93; unnamed Tertiary-Quaternary sediments of Basin 94; and the Santa Clara formation of Basin 105.

The U. S. Geological Survey has estimated the the storage capacity of five basins: Basin 87, 208,000 acre-feet; Basin 88, 480,000 acre-feet; Basin 92, 226,000 acre-feet; Basin 94, 380,000 acre-feet; and Basin 105, 1,580,000 acre-feet. No such estimates have been made for the deep aquifer systems in Quaternary alluvium or in the older Plio-Pleistocene water-bearing materials such as the Merced, Petaluma, Huichica, Glen Ellen, Montezuma, and Santa Clara formations and the Sonoma volcanics. Fresh water in storage and the storage capacity of water-bearing materials beneath San Francisco Bay are unknown but the potential may be large.

Limited quantities of ground water for domestic use may be obtainable from the joints, fractures, and weathered areas in the consolidated pre-Tertiary rocks that surround and underlie the ground water basins. These areas were not covered in the statewide inventory.

Table 41. STATUS OF SEA-WATER INTRUSION, SAN FRANCISCO BAY AREA

Basin No.	Basin Name	1953-55	1970-71
		MARIN COUNTY	
80	Horseshoe Bay	Status unknown	Status unknown
81	Richardson Bay	No apparent sea-water intrusion	Suspected sea-water intrusion
82	Ross Valley	No apparent sea-water intrusion	Suspected sea-water intrusion
83	San Rafael	Chlorides exceed 100 ppm	Suspected sea-water intrusion
84	Marin Island	Status unknown	Status unknown
85	San Pedro Point	No apparent sea-water intrusion	No information
86	Novato Valley	Chlorides exceed 100 ppm	No information
		MARIN AND SONOMA COUNTIES	
87	Petaluma Valley	Known sea-water intrusion	Area increasing
		SONOMA, NAPA, AND SOLANO COUNTIES	
88	Napa-Sonoma Valley	Known sea-water intrusion	Area may be increasing
		SOLANO COUNTY	
89	Southampton Bay	Chlorides exceed 100 ppm	No information
90	Benicia	Chlorides exceed 100 ppm	No information
91	Sulphur Springs	Status unknown	Status unknown
92	Suisun-Fairfield Valley	Suspected sea-water intrusion	Area may be decreasing
		SOLANO, SACRAMENTO, SAN JOAQUIN, AND CONTRA COSTA COUNTIES	
93	Sacramento-San Joaquin	Chlorides exceed 100 ppm	Suspected sea-water intrusion in several areas
		CONTRA COSTA COUNTY	
93A	Pittsburg Plain	Known sea-water intrusion in the 1930s	No information

Table 41. STATUS OF SEA-WATER INTRUSION, SAN FRANCISCO BAY AREA (Cont.)

Basin No.	Basin Name	1953-55	1970-71
	CONTRA COSTA COUNTY (Cont.)		
94	Clayton-Ygnacio Valley	Known sea-water intrusion in the 1930s	No information
95	Arroyo del Hambre	Status unknown	Status unknown
96	Little Bull	Status unknown	Status unknown
97	Big Bull	Status unknown	Chlorides exceed 100 ppm
98	Crockett	Status unknown	Status unknown
99	Canada del Cierbo	Status unknown	Chlorides exceed 100 ppm
100	Oleum	Status unknown	Chlorides exceed 100 ppm
101	Rodeo	Status unknown	No apparent sea-water intrusion
102	Refugio	Status unknown	Chlorides exceed 100 ppm
103	Pinole	Status unknown	Status unknown
104	Sobrante	Status unknown	Status unknown
	CONTRA COSTA, ALAMEDA, SANTA CLARA, AND SAN MATEO COUNTIES		
105	Santa Clara Valley	Known sea-water intrusion	Area increasing
	SAN MATEO COUNTY		
106	Guadalupe	Status unknown	Status unknown
	SAN FRANCISCO COUNTY		
107	Visitacion	Status unknown	Status unknown
108	Potrero	Status unknown	Status unknown
109	Islais	Status unknown	Status unknown
110	Market Street	Chlorides exceed 100 ppm	Area increasing
111	Fort Mason	Status unknown	Status unknown

BIBLIOGRAPHY

San Francisco Bay Area

Counties of Marin, Sonoma, Napa, Solano, Sacramento, San Joaquin Contra Costa, Alameda, Santa Clara, San Mateo, and San Francisco

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, San Francisco Sheet. 1961.

2. Geologic Map of California, Santa Rosa Sheet. 1963.

3. Geologic Map of California, Sacramento Sheet. 1966.

4. Geologic Map of California, San Jose Sheet. 1966.

California Department of Water Resources

5. Bulletin No. 13, Alameda County Investigation. March 1963. 196 pages.

6. Bulletin No. 7, Santa Clara Valley Investigation. June 1955. (Published by the former State Water Resources Board, which became part of the Department in 1956.)

7. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-29.

8. Bulletin No. 66, Quality of Ground Waters in California. April 1960. Plate 2.

9. Bulletin No. 66-58, Quality of Ground Waters in California. November 1960. Plate 2.

10. Bulletin No. 66-59, Quality of Ground Waters in California; Part I, Northern and Central California. February 1963. Unnumbered plate.

11. Bulletin No. 66-60, Quality of Ground Waters in California; Part I, Northern and Southern California. March 1964. Plates 5, 6, and 7.

12. Bulletin No. 66-62, Quality of Ground Waters in California; Part I, Northern and Central California. August 1964. Plates 3, 4, 5, and 6.

13. Bulletin No. 74-2, Water Well Standards: Alameda County. June 1964. 94 pages.

14. Bulletin No. 77-58, Ground Water Conditions in Central and Northern California. October 1959. Pp. 31-43.

15. Bulletin No. 81, Intrusion of Salt Water into Ground Water Basins of Southern Alameda County. December 1960. 74 pages.

16. Bulletin No. 118-1, Evaluation of Ground Water Resources in the South Bay; Appendix A: Geology. August 1967. 168 pages.

17. Bulletin No. 118-1, Evaluation of Ground Water Resources in the South Bay; Volume I, Fremont Study Area. August 1968. 136 pages. Volume II, Additional Fremont Study Area. August 1973. 57 pages.

18. Bulletin No. 123, Delta and Suisun Bay Water Quality Investigation. August 1967. 184 pages.

19. Bulletin No. 130 Series, Hydrologic Data: Volumes II and III, Appendixes C, D, and E. 1963 through 1971.

20. Bulletin No. 160-70, Water for California, the California Water Plan: Outlook in 1970. December 1970. 179 pages.

21. Bulletin No. 63, Sea-Water Intrusion in California; Appendix A, Status of Sea-Water Intrusion. December 1960. Pp. 61-96. (Unpublished office report.)

22. Alameda Creek Watershed Above Niles: Chemical Quality of Surface Water Discharges, and Ground Water. January 1964.

23. Ground Water Measurement of Sacramento Valley--Geology. Office Report. March 1966.

24. Land Subsidence Studies in the Sacramento District. Office Report. June 1967.

25. Pre-Project Ground Water Geology--North Bay Aqueduct. August 1967.

26. Long Range Plan for Waste Water Management in the Napa River Drainage Basin. November 1967.

27. Ground Water Conditions Effecting the Bay-Delta System, A Report Prepared for the San Francisco Bay-Delta Water Quality Program. March 1968. 35 pages and appendixes. Unpublished.

28. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

California Water Project Authority

29. Geology Appendix H of the Report to the Water Project Authority of the State of California on Feasibility of Contruction by the State of Barriers in the San Francisco Bay System. June 1955.

30. Investigation of the Sacramento-San Joaquin Delta. Ground Water Geology Report No. 1. May 1956. 21 pages.

U. S. Geological Survey

31. Water Resources of San Francisco Bay Area, California. Circular 378. 1957.

32. Physical and Hydrologic Properties of Waterbearing Deposits in Subsiding Areas in Central California. Professional Paper 497-A. 1968

33. Geology and Ground Water in Santa Rosa and Petaluma Valleys. Water Supply Paper 1427. 1958. 273 pages.

34. Geology, Water Resources, and Usable Ground Water Storage Capacity of Part of Solano County, California. Water Supply Paper 1464. 1960. 693 pages.

35. Geology and Ground Water in Napa and Sonoma Valleys, Napa and Sonoma Counties California. Water Supply Paper 1495. 1960. 252 pages.

36. Geologic Features and Ground Water Storage Capacity of the Sacramento Valley, California. Water Supply Paper 1497. 1961. 241 pages.

37. Subsidence in the Santa Clara Valley, California--A Progress Report. Water Supply Paper 1619-C. 1962. 16 pages.

38. Barriers and Ground Water Resources--1960. Corps of Engineers Comprehensive Survey, San Francisco Bay and Tributaries. 1960.

39. Bedrock-Surface Map of the San Francisco North Quadrangle, California, and Bedrock-Surface Map of San Francisco South Quadrangle, California. Basic Data Contribution 26. San Francisco Bay Region Environment and Resources Planning Study. Map report. 1964.

40. Land Subsidence in the Santa Clara Valley, Alameda, San Mateo, and Santa Clara Counties, California. Technical Report No. 2. San Francisco Bay Region Environment and Resources Planning Study. Map report. 1971.

41. Ground-Water Data as of 1967, San Francisco Bay Subregion, California. Open File Report. March 5, 1969. 5 pages.

42. Geologic Map of Late Cenozoic Deposits, Santa Clara County, California. Basic Data Contribution 27. San Francisco Bay Region Environment and Resources Planning Study. Map report. 1971.

Miscellaneous

43. Santa Clara-Alameda-San Benito Water Authority. Report on Primary Water Distribution System to Serve Proposed South Bay and Pacheco Aqueducts in North Santa Clara Valley. January 18, 1962.

44. Santa Clara Valley Water District. Ground Water Conditions 72-73. Annual Report. February 1974. 21 pages.

45. Tolman, C. F. and Poland, J. F. Investigation of the Ground Water Supply of the Columbia Steel Company, Pittsburg, California. Private report May 30, 1935.

46. Tolman, C. F. and Poland, J. F. Ground-Water, Salt-Water Infiltration, and Ground-Surface Recession in Santa Clara Valley, Santa Clara County, California. Transactions of the American Geophical Union. 1940. Pages 24-35.

47. U. S. Public Health Service, Region IX, San Francisco, California. Liquid Waste Inventory and Project--Supplement A to Public Health Aspects of Proposed Salt Water Barrier and Land Reclamation Projects, San Francisco Bay. March 1960.

Marin County
(Bay Shoreline)

HORSESHOE BAY BASIN - BASIN 80

Location	2 miles south of Sausalito
Bibliography	Items 1, 21, 27, 28, 39. Pages 96-98.
Description	Alluvium-filled valley, within military reservation, extends northwest from San Francisco Bay. Area: 0.2 square mile. Shoreline: 900 feet.
Water Use	Ground water not used.
Water-bearing Sediments	Unconsolidated alluvium overlain, at tide line, by Bay mud, possibly 100 feet deep at tide line. Physical characteristics unknown.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow probably maintains seaward hydraulic gradient.

Table 42. MINERAL ANALYSES, BASINS 80, 81, 82, 83, HORSESHOE BAY, RICHARDSON BAY, ROSS VALLEY, AND SAN RAFAEL

Item	Basin 80	Basin 81			
	Well	Surface Water		Wells	
	1S/6W-13M	Coyote Creek	Mill Creek	1S/5W-4,5,7	1S/6W-4,12,28,33
Date Sampled	1960s	-	-	-	1954
Character	-	$CaHCO_3$	$CaHCO_3$	-	$CaHCO_3$
Total Dissolved Solids (ppm)	-	186	91	-	165-393
Chlorides (ppm)	42	31	11	74-106	19-41

Item	Basin 82				Basin 83		
	Surface Water	Wells			Surface Water	Wells	
	Corte Madera	2N/7W-26H1	1N/6W-15N1	1N/6W-22R1	San Rafael Creek	2N/6W-34G1	1N/6W-4F1
Date Sampled	–	1954	1954	1954	–	1954	–
Character	$MgCaHCO_3$	$MgHCO_3$	$MgCaHCO_3$	$MgHCO_3$	$MgHCO_3$	$NaHCO_3$	$CaHCO_3$
Total Dissolved Solids (ppm)	128	157	2,249	390	174	223	507
Chlorides (ppm)	13	14	38	59	13	35	125

Marin County
(Bay Shoreline)

RICHARDSON BAY BASIN - BASIN 81

Location	8 miles north of San Francisco.
Bibliography	Items 1, 21, 27, 28. Pages 96-98.
Description	A six-mile-long alluvium-filled valley whose lower five miles the Bay waters have inundated. Of the alluvium-filled branches of this valley which now open onto Richardson Bay, Mill Valley and Coyote Creek Valley are the largest. Area: 3 square miles. Shoreline: 3 miles.
Water Use	Tiburon, Belvedere, Sausalito, and Mill Valley occupy most of the exposed alluvium, except for that in tidal marshes. The latter two cities support industries, including the construction and repair of small boats. Scattered wells provide the water used.
Water-bearing Sediments	Quaternary alluvium, unconsolidated, of unknown physical characteristics and thickness.
Ground Water Barriers	None known.
Offshore Geology	Except for an extensive outcropping of sand near Angel Island, the floor of Richardson Bay is composed of mud of unknown thickness. The sand, being permeable, may pass brackish or saline water to the fresh-water sediments of Richardson Bay Valley.
Sea-water Intrusion	Although limited data of 1954 suggested no sea-water intrusion, reports in 1972 suggest possible intrusion. Fresh-water inflow probably maintains a seaward hydraulic gradient in all but marsh areas. It probably keeps ground water levels above (or at) sea level along the coast. Before successful attempts were made to reclaim land from the Bay, tidal action affected about 40 percent of the valley. Locally, the hydraulic gradient might reverse and sea water might intrude if additional wells were dug in or near these reclaimed areas.

Marin County
(Bay Shoreline)

ROSS VALLEY BASIN - BASIN 82

Location	11 miles north of San Francisco.
Bibliography	Items 1, 21, 27, 28. Pages 96 - 98.
Description	A branching, alluvium-filled valley extending inland for three miles. Tides influence the bayward three miles of valley floor. Area: 6 square miles. Shoreline: 1.5 miles.
Water Use	Corte Madera, Larkspur, Kentfield, Ross, San Anselmo, and Fairfax occupy much of the valley. San Quentin prison lies in the northeast. Industry occupies tidal marshes. Shallow wells provide most of the water used. Except for those streams in the upper watershed which provide water for stock, surface water apparently goes unused.
Water-bearing Sediments	Quaternary alluvium, unconsolidated; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Mud of unknown thickness extends offshore for three miles.
Sea-water Intrusion	Although limited 1954 data suggested no sea-water intrusion, reports in 1972 suggest possible intrusion in lower portions of Ross Valley. Fresh-water inflow probably maintains a seaward hydraulic gradient in all but marsh areas. It probably keeps ground water levels above (or at) sea level along the coast. Before successful attempts were made to reclaim land from the bay, tidal action affected about 50 percent of the valley. Locally, the hydraulic gradient might reverse and sea water might intrude if additional wells were dug in or near these reclaimed areas.

Marin County
(Bay Shoreline)

SAN RAFAEL BASIN - BASIN 83

Location	12 miles north of San Francisco at San Rafael.
Bibliography	Items 1, 21, 27, 28. Pages 96-98.
Description	Alluvium-filled valley extending inland for three miles. Tides influence the bayward two miles of valley floor. Area: 3 square miles. Shoreline: 1.5 miles.
Water Use	San Rafael occupies much of the valley. Industry, including the construction and repair of small boats, concentrates in tidal marshlands next to U. S. Highway 101. Scattered shallow wells supply a small portion of local needs.
Water-bearing Sediments	Quaternary alluvium, unconsolidated; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Mud of unknown thickness extends offshore for three miles.
Sea-water Intrusion	In 1954, chlorides in Well No. 1N/6W-4F1 exceeded 100 parts per million. This may be normal for the area and may not indicate sea-water intrusion. Reports in 1972, however, suggest possible intrusion near San Francisco Bay. Fresh-water inflow probably maintains a seaward hydraulic gradient in all but marsh areas. It probably keeps ground water levels above (or at) sea level along the coast. Before successful attempts were made to reclaim land from the bay, tidal action affected about 50 percent of the valley. Locally, the hydraulic gradient might reverse and sea water might intrude if additional wells were dug in or near these reclaimed areas.

Marin County
(Bay Shoreline)

MARIN ISLAND BASIN - BASIN 84

Location	1 mile northeast of San Rafael.
Bibliography	Items 1, 21, 27, 28. Pages 96-98.
Description	Small alluvium-filled valley extending one-half mile inland from bay. Area: 0.2 square mile. Shoreline: 2,500 feet.
Water Use	Except for a large residential tract and for scattered private homes, the valley remains undeveloped. Use of either surface or ground water is not apparent.
Water-bearing Sediments	Quaternary alluvium, unconsolidated; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Mud of unknown thickness extends offshore for three miles.
Sea-water Intrusion	No information available. Fresh-water inflow probably maintains a seaward hydraulic gradient in all but marsh areas. It probably keeps ground water levels above (or at) sea level along the coast. Tidal action affects about 10 percent of the valley. Locally, the hydraulic gradient might reverse and sea water might intrude if additional wells were dug in or near this part of the valley.

Marin County
(Bay Shoreline)

SAN PEDRO POINT BASIN - BASIN 85

Location	2 miles northeast of San Rafael.
Bibliography	Items 1, 21, 27, 28. Pages 96 - 98.
Description	Alluvium-filled valley extending inland from San Francisco Bay. Area: 1 square mile. Shoreline: 1 mile.
Water Use	The entire valley is used to graze stock. Several shallow wells 15 to 20 feet, together with a small reservoir, provide water for crops and stock. A large brick plant is situated at the eastern edge of the valley.
Water-bearing Sediments	Unconsolidated, Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	As of summer 1954, limited data showed no sea-water intrusion or ground water degradation. No information available as of 1970-71. Fresh-water inflow probably maintains a seaward hydraulic gradient and holds ground water levels at or above sea level. Before successful attempts were made to reclaim land from the bay, tidal action affected about 70 percent of the valley. Locally, the hydraulic gradient might reverse and sea water might intrude if additional wells were dug in or near these reclaimed areas.

Table 43. MINERAL ANALYSES, BASIN 85, SAN PEDRO POINT

Item	Well No. 2N/6W-36H1
Date Sampled	1954
Character	$CaHCO_3$
Total Dissolved Solids (ppm)	274
Chlorides (ppm)	28

Marin County
(Bay Shoreline)

NOVATO VALLEY BASIN - BASIN 86

Location	11 miles north of San Rafael.
Bibliography	Items 2, 21, 27, 28, 33. Pages 96-98.
Description	Alluvium-filled valley that includes Gallinas and Santa Margarita Valleys and extends 12 miles west from San Pablo Bay. Area: 25 square miles. Shoreline: 6.5 miles.
Water Use	Limited to moderate development of ground and surface water for domestic, industrial, and agricultural uses and for stockwatering. Ground water lies generally 10 to 50 feet deep. Hamilton Air Force Base and the towns of Novato and Ignacio contain most of the population.
Water-bearing Sediments	Nonwater-bearing rock underlies unconsolidated Quaternary alluvium that ranges from 60 feet thick near Novato to more than 200 feet thick near the bay. Sand and gravel zones lying 25 to 50 feet deep yield an average 50 gallons per minute.
Ground Water Barriers	The Burdell Mountain fault, which extends southeast across the mouth of the valley, has no known effect on ground water movement.
Offshore Geology	Mud on the bay floor underlies the entire offshore area for more than 3 miles.
Sea-water Intrusion	In 1970 no information was available on an area of degraded ground water that had previously appeared in summer 1954. Brackish tides were thought to be the source, however.

Table 44. MINERAL ANALYSES, BASIN 86, NOVATO VALLEY

Item	Surface Water					Alluvium	Tidal Area Alluvium	Ground Water			
				Novato Creek				Wells			
	Gallinas Creek	Miller Creek	Arroyo San Jose	Upstream	Tidal Area			3N/6W-18G1	3N/6W-18M1	2N/6W-10L1	2N/6W-23H1
Date Sampled	-	-	-	-	-	-	-	1969	1969	1954	1954
Character	$CaMgHCO_3$	$CaHCO_3$	$CaHCO_3$	$MgHCO_3$	NaCl	$CaHCO_3$	NaCl	-	-	-	-
Total Dissolved Solids (ppm)	230	192	147	275	2,900	Moderate	400-1,600	-	-	1,560	372
Chlorides (ppm)	48	22	16	60	1,280	-	600-800	160	43	802	620

PETALUMA VALLEY - BASIN 87

Location	In Petaluma.
Bibliography	Items 2, 7, 10, 11, 12, 31, 33, 41. Pages 96-98.
Description	Alluvium-filled valley extending 16 miles northwest from San Pablo Bay. Area: 45 square miles. Shoreline: 3.5 miles.
Water Use	Unconfined ground water in the upper valley is extensively developed for agriculture and livestock, industry, and urban development. Surface water supplements the needs of Petaluma and local livestock. In the lower valley, which is largely made up of reclaimed tidal marshes, confined ground water has undergone only limited development. Some tidal marshes along the shore have not been reclaimed.
Water-bearing Sediments	Ground water occurs in a silt and clay deposit of unconsolidated Quaternary alluvium, 300 or more feet thick, having discontinuous lenses of sand and gravel, and also in the Merced and Petaluma formations, and the Sonoma volcanics of Pliocene to Pleistocene age. The Merced formation comprises sand, clay, and poorly consolidated sandstone that is a fair to good source for wells in the central and lower valley areas. At depths from 10 to 200 feet, these deposits can store 208,000 acre-feet of ground water.
Ground Water Barriers	The Burdell Mountain fault crosses the southwestern corner of the valley and the Hayward fault crosses its southeastern portion. Their effect on ground water movement is unknown.
Offshore Geology	Mud on the bay floor is about 75 feet thick at Point San Pablo.
Sea-water Intrusion	In 1954, several wells near the shoreline of the basin yielded water with chlorides exceeding 100 ppm. At the same time a small area of degraded ground water was identified near Petaluma. Summer pumping since 1954 has caused the water levels around Petaluma and in the tidal marshland to fall below sea level. The reversed hydraulic gradient has allowed the saline water in the Petaluma River to intrude inland as much as a mile in some areas. During the winter months, the normal bayward hydraulic gradient that occurs retards the saline intrusion and forms a fresh-water film over the brackish water. By 1962, the area of intrusion along the bay shoreline had grown to about 20 square miles, extending inland about 5 miles, and that near Petaluma had grown to about 25 square miles. The exact boundaries of these two areas were unknown in 1971, but they are assumed to be the same as in 1962.

PETALUMA VALLEY - BASIN 87 (Contd.)

Table 45. MINERAL ANALYSES, BASIN 85, PETALUMA VALLEY

Item	Surface Water					Ground Water				
	Petaluma River		Petaluma Creek	Adobe Creek	San Antonio Creek	Alluvium	Older Alluvium	Valley		
	Mouth	Petaluma						Upper	Middle	Lower
Character	NaCl	NaCl	$CaHCO_3$	$CaHCO_3$	$MgHCO_3$	$CaHCO_3$-$NaHCO_3$	NaCl	$CaHCO_3$	-	NaCl
Total Dissolved Solids (ppm)	-	-	390	187	177	-	-	-	-	-
Chlorides (ppm)	>1,000	>100	80	14	26	<100	>100	<100	50-250	100-1,000

Sonoma, Solano, and Napa Counties

NAPA-SONOMA VALLEY - BASIN 88

Location	About 30 miles northeast of San Francisco.
Bibliography	Items 2, 7, 10, 11, 12, 26, 31, 35, 41. Pages 96-98.
Description	Broad valley containing two narrow parallel alluvium-filled valleys, 40-mile-long Napa Valley and 15-mile-long Sonoma Valley. The two valleys merge at San Pablo Bay. Total area: 120 square miles. Area of Napa Valley: 85 square miles. Area of Sonoma Valley: 35 square miles. Shoreline: 9 miles.
Water Use	Heavily developed agriculture, industry, and municipalities make extensive use of the unconfined ground water in the inland portion of the basin. Municipal demands are supplemented by surface water. Reclaimed tidal marshlands make up most of the bayward portion. Some marshland along the shore remains undeveloped.
Water-bearing Sediments	Sand and gravel lenses in older parts of unconsolidated Quaternary alluvium that underlies the Napa-Sonoma Valley are the principal source of ground water. Thickness of the alluvium ranges from 300 to 500 feet. Yields are generally low in the younger alluvium. At depths from 10 to 200 feet, these deposits can store 480,000 acre-feet. Ground water also occurs in the Huichica formation of Pleistocene age, the Glen Ellen formation of Tertiary age, and the Sonoma volcanics of Tertiary age. The yield is moderate to low. Bayward ground water is entirely or partially confined. The hydraulic gradient is toward the bay. Estimated 1950 pumpage: Napa Valley: 5,500 acre-feet; Sonoma Valley: 2,500 acre-feet.
Ground Water Barriers	The Carneros fault crosses the bayward part of Napa Valley. Its effect on ground water movement is unknown.
Offshore Geology	Mud overlies the bay floor and is about 75 feet thick at Point San Pablo.
Sea-water Intrusion	In 1954, several wells near the shoreline yielded water with chlorides exceeding 100 ppm. At the same time, two small areas of degraded ground water occurred inland: one near Sonoma Creek about 6 miles inland and one near Napa River about 10 miles inland. The intrusion mechanism appears to resemble that of Petaluma Valley where saline water from tidal channels infiltrates when water levels are lowered and seasons of heavy pumping cause reversed hydraulic gradients.

Sea-water Intrusion (Cont.) By 1962, shoreline intrusion was reported to cover about 70 square miles and to extend inland about 6 miles. The larger area does not necessarily represent an increase in sea-water intrusion over that of 1954 but rather a more realistic evaluation of conditions. The exact extent of intrusion was not known in 1971 but it was assumed to equal that of 1962. A 1972 sample of a well near the confluence of Carneros Creek and the Napa River yielded 986 ppm chlorides.

Table 46. MINERAL ANALYSES, BASIN 88, NAPA-SONOMA VALLEY

Item	Napa River		Surface Water					Ground Water		
	Mouth	Napa	Schell Creek	Sonoma Creek	Suscol Creek	Huichica Creek	Carneros Creek	Alluvium	Older Alluvium	Recent Alluvium
Character	NaCl	NaCl	$CaHCO_3$	$MgHCO_3$	$CaHCO_3$	$NaHCO_3$	$CaHCO_3$	$CaHCO_3$	NaCl, $NaHCO_3$	-
Total Dissolved Solids (ppm)	500-20,000	-	143	142	136	104	190	-	-	Moderate
Chlorides (ppm)	200-10,000	>100	16	14	10	10	16	-	-	100-1,000

Solano County

SOUTHAMPTON BAY BASIN - BASIN 89

Location	About 2 miles west of Benicia.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	Small alluvium-filled valley extending north one mile from Carquinez Strait. Area: 0.5 square mile. Shoreline: 2,200 feet.
Water Use	Stock grazing in tidal marshlands and nearby hills is the only observed use of surface water. Ground water for domestic use has been developed to only a limited extent.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness are unknown.
Ground Water Barriers	The Southampton fault, extending along the east side of the valley, is not known to affect ground water movement.
Offshore Geology	A fairly deep sand-filled channel paralleling the shore about one mile to the south cuts through a mile-long area of mud and soft clay of unknown thickness.
Sea-water Intrusion	Water well samples taken in 1954 and 1964 indicated no change in an area of degraded ground water that occurred in the upper part of the basin in 1954. There is no information available as of 1970-71. Brackish or saline water in the tidal marshes are believed to be the source. Ground water level in spring 1955 was 17 feet deep; no information available as of 1970-71.

Table 47. MINERAL ANALYSIS, BASIN 89, SOUTHAMPTON BAY

Item	Well No. 3N/3W-28A1
Date Sampled	1954
Character	$NaHCO_3$
Total Dissolved Solids (ppm)	958
Chlorides (ppm)	190

BENICIA BASIN - BASIN 90

Location	At Benicia, about 6 miles southeast of Vallejo.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	Small area of alluvium and tidal marshland extending along the bay on the north side of Carquinez Strait. Area: 0.5 square mile. Shoreline: 1.5 miles.
Water Use	Limited development for domestic use. Benicia, the main population center, obtains water from Sulphur Spring Reservoir and Solano Irrigation District. Tidal marshland is undeveloped.
Water-bearing Sediments	Unconsolidated Quaternary alluvium and adjacent terrace deposits; physical characteristics and thickness are unknown.
Ground Water Barriers	Unknown.
Offshore Geology	Entire area underlain by mud and soft clay of unknown thickness.
Sea-water Intrusion	Two small degraded areas that were discovered along the shore in summer 1954 had apparently advanced slowly inland by 1969. Brackish or saline water in the tidal area of Benicia Valley and a large dump area are believed to be the source of the intrusion. No information was available as of 1970-71. In spring 1955 the ground water level in the tidal marshes was 20 feet deep.

Table 48. MINERAL ANALYSES, BASIN 90, BENICIA

Item	Wells	
	Alluvial Plain	Terrace Deposits
Location Number	2N/3W-1N1	
Date Sampled	-	1954
Character	NaCl	$CaMgSO_4$
Total Dissolved Solids (ppm)	2,000	2,300
Chlorides (ppm)	800-1,000	400

SULPHUR SPRINGS BASIN - BASIN 91

Location	Two miles northeast of Benicia.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	Long, narrow alluvium-filled valley extending $6\frac{1}{2}$ miles northwest from Suisun Bay. Area: 1 square mile. Shoreline: 1.2 miles.
Water Use	Surface and ground water are moderately developed for domestic and livestock use. Sulphur Springs Reservoir supplies Benicia.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness are unknown.
Ground Water Barriers	The Sulphur Spring Valley fault crosses the eastern part of the valley. No information is available to determine whether this fault may form a barrier to ground water movement
Offshore Geology	Entire area underlain by mud and soft clay of unknown thickness.
Sea-water Intrusion	No information available in the coastal segment of this valley. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient in the entire basin.

Solano County

SUISUN-FAIRFIELD VALLEY - BASIN 92

Location	About 12 miles northeast of Vallejo, extending from the communities of Spring Valley to Collinsville.
Bibliography	Items 2, 3, 12, 18, 25, 31, 34, 41, 47. Pages 96-98.
Description	Broad alluvium-filled valley bordering the north shore of Suisun Bay and extending northward 14 miles. Because a large part of the valley lies at or below sea level, it is influenced by tides. Area: about 170 square miles. Shoreline: about 20 miles.
Water Use	Ground and surface water is highly developed for agriculture, industry, and municipalities in the northern part of the valley. In 1949 an estimated 7,900 acre-feet of ground water was being pumped. In 1954 ground water was overdrawn. The communities of Fairfield, Suisun, and Cordelia, and Travis Air Force Base are the principal population centers. Surface water in numerous reservoirs and ponds serves municipal and stockwatering needs. Ground water serves domestic and municipal needs, irrigation, and stockwatering. Some part of the tidal marshland has been reclaimed for stock grazing and dry farming, but much of this land remains unreclaimed.
Water-bearing Sediments	Unconsolidated Quarternary alluvium is the principal source of ground water, which also occurs to a limited extent in interbedded tuff, tuff breccia, and agglomerate in Sonoma volcanics of Pliocene age. The older coarse-grained alluvium is overlain by about 60 feet of a fine-grained phase. Its total thickness near Suisun Bay may exceed 300 feet. Cretaceous marine formations east of Suisun Creek, which range in depth from ground surface east of Fairfield to more than 200 feet at Suisun Creek, underlie the alluvium. Marine connate water commonly occurs in wells drilled in or near Cretaceous formations. At depths from 10 to 200 feet, these deposits can store 226,000 acre-feet of ground water.
Ground Water Barriers	The Green Valley fault, which crosses part of the western side of the valley, is not known to affect the movement of alluvial ground water.
Offshore Geology	Except for some isolated sand-filled channels, the entire area is underlain by mud and soft clay of unknown thickness.
Sea-water Intrusion	In 1954, several wells near the shoreline yielded water with chlorides exceeding 100 ppm. The intrusion mechanism in this basin appears to have been similar to those occurring in Petaluma Valley and in Napa-Sonoma Valley. Saline water

Sea-water Intrusion (Cont.)

from tidal channels infiltrated when lowered water levels during seasons of heavy pumping caused reversed hydraulic gradients.

By 1962, the area of suspected intrusion in the bayward part of the basin was extended when the widespread occurrence of well water containing chlorides above 100 ppm was determined. More recent studies undertaken in part for the inventory reported here suggest that a fairly large shoreline area of the basin south of Fairfield is underlain by brackish-to-saline water. This area, which is bounded by Highway 21 on the west and by Highway 12 on the north and east, may extend as much as 15 miles inland and may underlie an area of 225 square miles. However, available data only verifies the occurrence of degraded water at individual wells.

This area has a complicated history of ground water development that frustrates any effort to establish an accurate sequence of sea-water intrusion events. Despite this situation, three points can be cited to illustrate the general course of events. By 1950, ground water levels in a six-mile area west of Fairfield had fallen below sea level and ground water moved toward a cone of depression; by October 1966 greater local dependence on water from the Putah South Canal caused the cone to disappear; and by 1970, ground water levels exceeded sea level in many locations and the hydraulic gradient was believed to slope from hills in the upper valley toward the bay.

Table 49. MINERAL ANALYSES, BASIN 92, SUISUN-FAIRFIELD VALLEY

Item	Surface Water		Wells	
			Alluvial Plain	
	Green Valley Creek	Suisun Creek	Upper Valley	Lower Valley
Character	$CaHCO_3$	$CaHCO_3$	$MgHCO_3$	NaCl
Total Dissolved Solids (ppm)	172	220	-	2,000-3,500
Chlorides (ppm)	20	12	100-500	800-1,500

Solano, Sacramento, San Joaquin, and Contra Costa Counties
(Bay Shoreline)

SACRAMENTO-SAN JOAQUIN DELTA - BASIN 93

Location	An area west of Stockton, south of the city of Sacramento, and north of the city of Tracy.
Bibliography	Items 3, 4, 18, 21, 23, 24, 27, 30, 34, 36. Pages 96-98.
Description	Reclaimed tidal marshland. Area: 625 square miles. Shoreline: unknown distance along the Sacramento and San Joaquin Rivers.
Water Use	Agriculture and industry are served by local development of ground water and extensive development of surface water. Domestic needs and livestock are served by ground water. Upper zones of ground water are influenced by tidal action. The hydraulic gradient is westward in the eastern Delta and uncertain in other parts.
Water-bearing Sediments	Yields of ground water from unconsolidated valley fill materials of Quaternary age are fair to good. In the western Delta, the Montezuma formation of Tertiary-Quaternary age yields somewhat less ground water. Underlying Tertiary water-bearing materials yield poorly.
Ground Water Barriers	None known.
Sea-water Intrusion	Except for local lenses of fresh water that may derive from channel seepage, the Delta generally contains ground water of undesirable mineral quality. Although its origin is open to question, this inferior water, which may have accumulated in the valley trough during geologic time, may now be flushed upward by rising sedimentary marine connates. It may also be affected by the flow reverses and incursions of sea water caused by the tides. Dredging operations to widen and deepen the Delta channels for navigation may have removed some of the impermeable materials and allowed increased recharge. Either connate brackish water or sea-water intrusion caused the rise in chlorides noted in the Stockton, French Camp, and Tracy areas. The exact location and extent of areas of degraded ground water in the Delta area were not known as of 1970-71; therefore, no attempt has been made to show these waters on the Delta area map in this report.

Table 50. MINERAL ANALYSES, BASIN 93, SACRAMENTO-SAN JOAQUIN DELTA

Item	Surface Water		Wells			
	Sacramento River at Freeport	San Joaquin River at Vernalis	4N/3E-14F	2N/6E-16C	1N/4E-3N	1N/6E-10Q
Character	$CaHCO_3$	NaCl	$NaHCO_3$	$CaHCO_3$	$NaHCO_3$	NaCl
Total Dissolved Solids (ppm)	65-133	58-548	-	374	-	-
Chlorides (ppm)	3-9	17-150	96	32	166	442

Item	Wells						
	1S/4E-14M	1S/6E-23C	2S/4E-6L	2S/5E-22Q	2S/6E-30G	3S/5E-35B	3S/6E-7F
Character	NaCl	NaCl	NaCl	NaCl	NaCl	Na_2SO_4	NaCl
Total Dissolved Solids (ppm)	-	324	-	-	1,360	1,480	-
Chlorides (ppm)	196	101	539	252	332	58	420

PITTSBURG PLAIN - BASIN 93A

Location	From Port Chicago east 18 miles to Oakley.
Bibliography	Items 2, 3, 4, 21, 27, 28, 31, 43. Pages 96-98.
Description	Alluvial plain about 12 miles long and 2 miles wide that slopes northeast. Marshland borders the Sacramento and San Joaquin Rivers. Area: 24 square miles. Shoreline: 12 miles.
Water Use	A highly industrialized area supplied chiefly by imported water carried by the Contra Costa Canal. Some ground water is extracted east and west of Pittsburg. About 1,200 acre-feet were pumped in 1969.
Water-bearing Sediments	Major water-bearing unit is formed of alluvial fan deposits of Pleistocene to Recent age consisting of highly lenticular beds of gray and brown sand, sand and gravel, and blue and yellow clay. The maximum thickness of these deposits is 400 feet.
Ground Water Barriers	None known.
Offshore Geology	Aquifers in the water-bearing materials are hydrologically connected with the Sacramento River.
Sea-water Intrusion	The status of degraded ground water near Antioch was unknown in 1970. Industrial users extracted large amounts in Pittsburg as early as 1930, causing ground water levels to fall at least 20 feet below sea level. Sea water then intruded and many wells were abandoned. The availability of large supplies of surface water for municipal and industrial users halted the heavy draft; the return of a normal bayward hydraulic gradient may now be flushing out the saline water. However, a 1972 sample of one well still indicated a chloride content of 610 ppm.

Table 51. MINERAL ANALYSES, BASIN 93A
PITTSBURG PLAIN

Item	Ground Water
	Older Pleistocene Alluvium
Total Dissolved Solids (ppm)	$\approx$1,000
Chlorides (ppm)	100-600

CLAYTON-YGNACIO VALLEY - BASIN 94

Location	On the south shore of Suisun Bay; contains the cities of Concord and Walnut Creek.
Bibliography	Items 1, 3, 4, 21, 27, 28, 31, 41. Pages 96-98.
Description	An alluvium-filled valley extending 14 miles south from Suisun Bay. Area: 50 square miles. Shoreline: 5 miles.
Water Use	Except for a narrow undeveloped tidal marshland, the valley is developed to agriculture, industry, and residential areas which are served by imported surface water. Ground water has undergone limited development and serves agricultural and municipal needs. Concord, Clayton, and Walnut Creek are the principal population centers.
Water-bearing Sediments	Unconsolidated Quaternary alluvium and semi-consolidated Tertiary-Quaternary deposits with interbedded lenses of clays, sands, and gravels contain the main ground water supply. Thickness of the alluvium is unknown. Valley sediments become progressively finer toward the bay. At depths from 10 to 200 feet, these deposits can store 380,000 acre-feet of ground water.
Ground Water Barriers	Trending northwest, the Concord fault impedes ground water movement between the Clayton and Ygnacio Valleys and, along with a wedge of bedrock, restricts the shoreline length of an area of permeable deposits to about one-fourth mile.
Offshore Geology	Entire area is underlain by mud and soft clay of an unknown thickness. A fairly deep sand-filled channel incising the mud about three-fourths mile offshore parallels the shoreline. Brackish and saline water contained in the channel sand intrude water-bearing deposits in the bayward extension of Clayton Valley.
Sea-water Intrusion	Sea water apparently intruded the bayward portion of the valley in 1930 when large amounts of ground water were extracted for local use. In 1955 an apparent bayward hydraulic gradient was diluting the brackish water. Imported surface water now being used will add fresh water to the ground water reservoir. The exact location and extent of degraded ground water in this basin were not known in 1971.

Table 52. MINERAL ANALYSES, BASIN 94, CLAYTON-YGNACIO VALLEY

Item	Surface Water at Hastings Street	Ground Water in Quaternary Deposits
Character	NaCl	Unknown
Chlorides (ppm)	100	150 to 600

ARROYO DEL HAMBRE - BASIN 95

Location	At Martinez, about 9 miles southeast of Vallejo.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A narrow alluvium-filled valley extending 5 miles south from Carquinez Strait. Area: 2 square miles. Shoreline: about 5,000 feet.
Water Use	Except for a narrow tidal strip, the entire bayside portion of the valley is occupied by commercial, industrial, and residential sections of Martinez. Shell Chemical Corporation plant occupies the eastern part of the valley. Local water needs are supplied by the East Bay Municipal Utility District and the Contra Costa Canal. No use of surface or ground water has been observed.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a deep, sand-filled channel that incises mud and soft clay about one-half mile offshore.
Sea-water Intrusion	No information available as of 1970-71. Fresh-water inflow to the bayward area of the basin is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin. Data are insufficient to determine the cause for high chlorides that occurred in 1931 in one well situated three miles inland.

Table 53. MINERAL ANALYSES, BASIN 95, ARROYO DEL HAMBRE

Item	Surface Water	Well No.
	Arroyo Del Hambre	2N/2W-30L
Date Sampled	-	1931
Character	$NaHCO_3$	-
Total Dissolved Solids (ppm)	942	-
Chlorides (ppm	122	2,445

LITTLE BULL BASIN - BASIN 96

Location	About 2 miles west of Martinez.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A small alluvium-filled valley extending one-half mile west along Carquinez Strait. Area: about 0.1 square mile. Shoreline: about 1,700 feet.
Water Use	Entire valley is occupied by the Port Costa brickyard and docking facilities whose water needs are probably supplied by a small reservoir on Little Bull Creek. No use of ground water has been observed.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises mud and soft clay about one-half mile offshore.
Sea-water Intrusion	No information available in bayward area as of 1970-71. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

Table 54. MINERAL ANALYSIS, BASIN 96, LITTLE BULL

Item	Well No. 2N/3W-10P
Date Sampled	1970
Chlorides (ppm)	24

BIG BULL BASIN - BASIN 97

Location	At Port Costa, about 5 miles southeast of Vallejo.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A small alluvium-filled valley extending one-half mile along Carquinez Strait. Area: 0.15 square mile. Shoreline: about 500 feet.
Water Use	Water from wells supplies Port Costa, whose urban and commercial sections occupy the entire shoreline of the valley. Stock grazes the upper valley.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises mud and soft clay about one-half mile offshore.
Sea-water Intrusion	In 1970 chlorides exceeding 100 ppm were reported in a well near the shoreline. The source of this intrusion is not known. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

Table 55. MINERAL ANALYSIS, BASIN 97, BIG BULL

Item	Well No. 2N/3W-3L
Date Sampled	1970
Chlorides (ppm)	108

Contra Costa County

CROCKETT BASIN - BASIN 98

Location	At Crockett.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A small alluvium-filled valley extending 0.7 mile south from Carquinez Strait. Area: 0.3 square mile. Shoreline: about 3,000 feet.
Water Use	The entire valley and adjacent foothills are occupied by urban and commercial sections of Crockett. Facilities of the C and H Sugar Company occupy a large part of the valley near the Carquinez Strait. East Bay Municipal Utility District and the Contra Costa Canal supply local water needs.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises mud and soft clay about one-half mile offshore.
Sea-water Intrusion	No information available. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

Table 56. MINERAL ANALYSIS, BASIN 98, CROCKETT

Item	Ground Water
	Coastal Alluvium
Date Sampled	1970
Chlorides (ppm)	80-100

CANADA DEL CIERBO BASIN - BASIN 99

Location	At Tormey, about 1.5 miles northeast of Rodeo.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A small alluvium-filled valley extending 2 miles southeast from Carquinez Strait. Area: about 0.2 square mile. Shoreline: about 2,000 feet.
Water Use	The community of Tormey and the Selby plant of the American Smelting and Refinery Company occupy the bayward part of the valley. Upper portion of valley is used solely to graze stock. A few wells are located at Tormey.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises mud and soft clay about one-half mile offshore.
Sea-water Intrusion	Several open-pit wells in Tormey contain highly brackish water that possibly is derived from industrial waste water, not from intruded sea water. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

Table 57. MINERAL ANALYSES, BASIN 99, CANADA DEL CIERBO

Item	Well No.	
	2N/3W-6M	2N/4W-1H
Date Sampled	1970	1970
Chlorides (ppm)	162	1,640

OLEUM BASIN - BASIN 100

Location	About 1 mile northeast of Rodeo.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A small alluvium-filled valley extending one mile southeast from San Pablo Bay. Area: about 0.25 square mile. Shoreline: about 2,000 feet.
Water Use	Entire valley is occupied by Union Oil Company storage tanks and ponds. Use of surface or ground water has not been observed.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises mud and soft clay about one mile offshore.
Sea-water Intrusion	Brackish water found in wells sampled in this basin is characteristic of wells in the area; it does not indicate sea-water intrusion. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

Table 58. MINERAL ANALYSIS, BASIN 100, OLEUM

Item	Upper Valley Well No. 2N/4W-12B
Date Sampled	1970
Chlorides (ppm)	114

Contra Costa County

RODEO BASIN - BASIN 101

Location	At Rodeo.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A narrow alluvium-filled valley extending 6 miles southeast from San Pablo Bay. Area: about 1.3 square miles. Shoreline: about 1,800 feet.
Water Use	Urban and commercial portions of Rodeo occupy the bayward part of the valley. Stock grazing in the upper part of the valley are watered by supplies from numerous small reservoirs dammed in the upper watershed. East Bay Municipal Utility District and the Contra Costa Canal supply local water needs. A few water wells are used in the bayward portion of the valley.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises mud about one mile offshore.
Sea-water Intrusion	No apparent sea-water intrusion. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

Table 59. MINERAL ANALYSES, BASIN 101, RODEO

Item	Rodeo Creek	Ground Water Alluvium (Lower half of valley)
Date Sampled	-	1970
Character	$NaSO_3$	-
Total Dissolved Solids (ppm)	1,820	-
Chlorides (ppm	157	26-32

REFUGIO BASIN - BASIN 102

Location	About 1 mile northwest of Pinole.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A branching alluvium-filled valley extending two miles from San Pablo Bay. Area: 0.9 square mile. Shoreline: about 1,200 feet.
Water Use	Facilities of the Hercules Powder Company occupy the entire bayward portion of the valley. A limited amount of surface water is used to water stock grazing in the upper valley. No development of ground water has been observed.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Entire offshore area is underlain by mud of unknown thickness. Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises the mud about two miles offshore.
Sea-water Intrusion	Although the status of sea-water intrusion in the shoreline part of the valley is unknown, one inland well in 1970 was found to have chlorides exceeding 100 parts per million. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

Table 60. MINERAL ANALYSIS, BASIN 102, REFUGIO

Item	Well No. 2N/4W-14R
Date Sampled	1970
Chlorides (ppm)	136

PINOLE BASIN - BASIN 103

Location	At Pinole.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	A narrow alluvium-filled valley extending 4 miles south of San Pablo Bay. Area: about 9.7 square miles. Shoreline: about 2,000 feet.
Water Use	Except for a small urban area at Hercules, the section of the valley extending one-half mile inland is undeveloped. Pinole, lying in the valley center, is the major population center. The upper valley, where shallow windmills supply local domestic and stockwatering needs, is occupied by many small diversified farms. Other than stockwatering, no use of surface water has been observed.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics and thickness unknown.
Ground Water Barriers	No information is available to determine whether the Pinole fault forms a barrier to ground water movement as it crosses the bayward part of the valley.
Offshore Geology	Mud of unknown thickness underlies the entire offshore area for about $2\frac{1}{2}$ miles. Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises the mud about $2\frac{1}{2}$ miles offshore.
Sea-water Intrusion	No information available in the bayward portion of the valley. One well several miles inland contained chlorides less than 100 ppm when sampled in 1970. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

Table 61. MINERAL ANALYSES, BASIN 103, PINOLE

Item	Pinole Creek	Well No. 2N/4W-22E
Date Sampled	-	1970
Character	$CaSO_4$	-
Total Dissolved Solids (ppm)	1,100	-
Chlorides (ppm)	90	70

SOBRANTE BASIN - BASIN 104

Location	About 2 miles west of Pinole.
Bibliography	Items 2, 21, 27, 28. Pages 96-98.
Description	An alluvium-filled valley extending along the southern shore of San Pablo Bay. Area: about 0.7 square mile. Shoreline: about 2.5 miles.
Water Use	Undeveloped tidal marshland comprises most of the valley. The Atlas Powder Company occupies Pinole Point and some adjacent marshland. Several shallow windmills supply water for stock grazing the upper valley.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics or thickness unknown.
Ground Water Barriers	None known.
Offshore Geology	Mud of unknown thickness underlies the entire area for about $1\frac{1}{2}$ miles from shore. Water-bearing deposits in the bayward extension of the valley are probably exposed to brackish or saline water contained in a fairly deep sand-filled channel that incises the mud about $1\frac{1}{2}$ miles offshore.
Sea-water Intrusion	No information available. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the basin.

SANTA CLARA VALLEY - BASIN 105

Location	In and around southern San Francisco Bay Area.
Bibliography	Items 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 21, 22, 27, 31, 37, 38, 40, 42, 43, 44, 46. Pages 96-98.
Description	A wide, elongated, alluvium-filled valley extending from Richmond in Contra Costa County about 70 miles southeast to a drainage divide near Morgan Hill in Santa Clara County. Area: about 458 square miles. Shoreline: about 96 miles.

The following discussion of Santa Clara Valley is divided geographically into four parts: East Bay Plain Area, Fremont Area, Santa Clara Area, and West Bay Plain Area. These are discussed on pages 130-134.

Table 62. MINERAL ANALYSES, BASIN 105, SANTA CLARA VALLEY

Item	East Bay Ground Water		Fremont Area Ground Water: Newark Aquifer	Fremont Area Ground Water: Centerville/ Fremont Aquifer	Fremont Area Ground Water: Lower Aquifer	Fremont Area Ground Water: Aquifer Above Hayward Fault	Santa Clara Area Ground Water		West Bay Plain Area Ground Water	
Date Sampled	1970	1972	1973	1973	1973	1973	1970	1972	1970	1973
Chlorides (ppm)	30-850	30-2,300	40-28,000	20-2,800	15-1,000	40-140	11-2,400	5-114	50-430	60-460

EAST BAY PLAIN AREA

Location	Along the east side of San Francisco Bay in Contra Costa and Alameda counties, extending from Pinole Point in Contra Costa County south to about the northern edge of the Niles Cone near the San Mateo Bridge.
Description	A densely populated metropolitan area that occupies the alluvial plain lying between the Bay shoreline and the Berkeley Hills and contains five major population centers: Oakland, Berkeley, Richmond, Alameda, and San Leandro. Part of the shoreline is developed industrially.
Water Use	Most water is imported from the Sierra Nevada by the East Bay Municipal Utility District. Scattered wells supply individual dwellings, a few commercial and industrial developments, and irrigated agriculture on Bay Farm Island.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium. Five formations overlie the bedrock (from topmost downward): bay mud, the Merritt sand, the Posey formation, the San Antonio formation, and the Alameda formation. The Merritt sand supplies fresh water for shallow wells; aquifers in the Alameda formation supply fresh water for deep wells. Known thickness of the water-bearing materials is 760 feet. Nonwater-bearing rocks underlying the area are exposed at Point Richmond Hills.
Ground Water Barriers	The Hayward fault, the only known barrier to ground water movement, affects all water-bearing sediments as it trends northwest-southeast between Castro Valley and Hayward.
Offshore Geology	Generally impermeable mud ranging in thickness from 0 to 100 feet underlies San Francisco Bay, restricting downward percolation of saline bay water. An exception to this condition is two square miles of sand lying opposite the mouth of San Leandro Creek in San Leandro Bay that may be sufficiently permeable to admit sea water into water-bearing sediments containing fresh water. Sea water is presently intruding from the mouth of the creek.
Sea-water Intrusion	The location and extent of ground water degraded by sea-water intrusion through 1971 have not been well documented. For that reason, several areas discussed here do not appear in Figures 5 and 6. Intrusion along San Leandro Creek extending about 1.5 miles inland has been occurring at an estimated rate of 250 feet per year. From 1962 through 1965, sea water moved inland about 0.15 miles. Intrusion along the Oakland Estuary dates from the 1870s when the depth of San Antonio Creek was increased from 8 feet to 30 feet to accommodate ocean-going vessels. This work cut into the ground water aquifer, allowing sea water to intrude. High chloride water contained in a group of wells along upper San Pablo Creek is probably derived from connate water.

FREMONT AREA

Location	Along the southeast side of San Francisco Bay, primarily in southern Alameda County. Extends from the region of the San Mateo Bridge south to the Alameda-Santa Clara County line; includes a portion of San Francisco Bay west to the shore of San Mateo and Santa Clara counties.
Description	A sloping alluvium-covered plain lying between the Diablo Range on the east and the eastern shore of San Francisco Bay and extending beneath San Francisco Bay to its western shore. The area includes three cities: Fremont, Newark, and Union City.
Water Use	Ground water supplies about 85 percent of the need for agriculture, municipalities, and industry. Smaller quantities of surface water and imported water from South Bay, Sunol, and Hetch Hetchy Aqueducts augment the ground water supply. Much of the tidal marshland zone is used by the salt processing industry as evaporating beds for sea water.
Water-bearing Sediments	Ground water occurs in unconsolidated alluvium of Quaternary age and in the older Santa Clara formation of Tertiary and Quaternary age. The alluvium comprises a series of sand and gravel aquifers and clay aquitards that are as much as 100 feet thick. From the topmost downward, these are the Newark, the Centerville, the Fremont, the "400-foot," and the "500-foot" aquifers. In the easternmost part of the area near Niles, the gravel constitutes nearly the total thickness of the alluvium and forms the ground water forebay. Toward the west, both the thickness and grain size of the aquifers decrease, while the intervening clay beds thicken, resulting in a westward reduction in the overall transmissive characteristics of the alluvium. Yields of 1,000 gallons per minute from water wells are common. The Santa Clara formation is very permeable where exposed in the eastern part of the basin. Its contribution to the ground water supply elsewhere is small because of the effects of the Hayward fault and because the beds in this formation decrease in permeability toward the Bay.
Ground Water Barriers	Ground water movement, particularly in the Niles Cone area, is impeded by the Hayward fault, an active fault that extends in a northwest-southeast direction along the eastern edge of the alluvium. The fault is marked by elongated depressions, offset stream courses, and small escarpments. In 1958 the ground water level on the northeast side of the fault was 97 feet higher than that on the

southwest side--the maximum difference recorded. The difference in water levels across the fault is not constant throughout the year.

Offshore Geology

San Francisco Bay is underlain by low-permeability mud ranging from 0 to 100 feet thick that prevents rapid percolation of saline bay water. At the Dumbarton Strait, the mud and the Newark aquitard are relatively thin and apparently permit intrusion into the Newark aquifer.

Sea-water Intrusion

Intrusion in this area was first noted in 1924, when an increasing irrigation draft lowered ground water levels 30 to 40 feet below sea level. Many wells were abandoned, new wells were drilled, and many wells were deepened to tap the Centerville and Fremont aquifers and the lower aquifers, thereby avoiding the saline water that had entered the Newark aquifer. Water levels continued to fall and sea water continued to encroach until, by 1950, degraded water from the Newark aquifer was percolating into the Centerville and Fremont aquifers near Niles and gaining access to the lower aquifers by percolation through the unconfined forebay area and through improperly abandoned wells. Once in the lower aquifers, the saline water moved toward the Bay along the westward hydraulic gradient.

By the period 1953-1955, saline water had advanced some 2 to 7 miles inland into the shallow Newark aquifer, and ground water with chlorides exceeding 100 ppm underlay about 150 square miles. During this same period, about five square miles of degraded water occupied the deeper Centerville aquifer. By fall 1970, the area of degraded water in the Centerville aquifer was more exactly defined as underlying an area of about 30 square miles. Intrusion in the Newark aquifer had continued to 1970 from the earlier period, but the exact boundary of the 100-ppm chloride line is unknown because of the effects of a program of artificial ground water recharge conducted by the Alameda County Water District.

In general, the annual volume of salt water entering the basin between 1963 and 1972 has been decreased by the recharge program in the forebay area. Although recharge has caused water levels to recover in the basin, a critical situation still exists because of the presence of large volumes of high chloride ground water in both the Newark and Centerville aquifers.

SANTA CLARA AREA

Location	South of San Francisco Bay in Santa Clara County, extending from the Bay about 24 miles south to the drainage divide near Morgan Hill.
Description	The alluvium-filled portion of southern Santa Clara Valley bounded on the west by the Santa Cruz Mountains and on the east by the Diablo Range. The area includes the Palo Alto-San Jose-Santa Clara megalopolis.
Water Use	Ground water is the chief source for rapidly dwindling acreages of crops and orchards and for part of the heavily populated metropolitan areas. The area is becoming increasingly dependent on imported surface water. The bay shoreline is part of the San Francisco Bay National Wildlife Refuge.
Water-bearing Sediments	Ground water occurs mainly in lenticular layers of sand, gravel, clay, and silt contained in unconsolidated Quaternary alluvium, as well as in the older semiconsolidated Santa Clara formation of Tertiary-Quaternary age. The combined thickness of these two units exceeds 1,000 feet. Along the tidal area, the sediments contain a higher percentage of clay and are therefore less permeable. Water wells there commonly yield more than 1,000 gallons per minute. Wells situated along the western edge of the area, which penetrate and draw water from the Santa Clara formation beneath the alluvium, also have high yields. However, other wells drawing from the same formation at higher elevations obtain only moderate to low yields.
Ground Water Barriers	The western margin of the area is underlain at shallow depths by the Santa Clara formation which dips steeply beneath the Quaternary alluvium and which may act as a partial barrier to ground water flow. Faults in the alluvium may act as local barriers where buried stream channels have been cut off.
Offshore Geology	San Francisco Bay is underlain by low-permeability mud ranging in thickness from zero to more than 100 feet that prevents rapid downward movement of saline water. The Newark aquifer extends from the Fremont area beneath the mud to the west shore of the Bay.
Sea-water Intrusion	Degraded water found near the shoreline in the 1940s was believed to prove that sea water had intruded into the upper aquifers of the area. Although water levels in the deeper aquifers have been dropping since that time, there was no evidence of direct intrusion in 1971 or that degraded water in the shallow bayward aquifers was moving inland. The greatest danger appears to lie in the possibility of downward movement of shallow degraded water through improperly constructed and improperly abandoned water wells.

WEST BAY PLAIN AREA

Location	Along the west side of San Francisco Bay in San Mateo County, extending from Brisbane south about 22 miles to the San Mateo-Santa Clara County line.
Description	An alluvium-covered plain lying between the western shoreline of San Francisco Bay and the San Bruno Mountains to the west. The area includes five population centers: San Bruno, Burlingame, San Mateo, San Carlos, and Menlo Park.
Water Use	Water imported by the Hetch Hetchy system serves the entire area, most of which is occupied by urban and industrial development. A few wells serve local needs.
Water-bearing Sediments	Unconsolidated Recent alluvium is underlain at depths up to 100 feet by older, probably Pleistocene, alluvium. Total depth of the sequence is at most 1,000 feet. Non-bearing rocks lie below the sequence and outcrop at San Mateo Point and Point San Bruno. Quaternary marine sediments that are partly water-bearing extend northwest through the San Bruno trough and are in hydrologic continuity with sediments in the Merced Valley basin.
Ground Water Barriers	The San Bruno and Hillside faults in the northwestern part of the area may have some effect on ground water movement; however, there is no definite evidence that these faults are barriers.
Offshore Geology	Bay mud that is 75 or more feet thick lies on the floor of the west side of San Francisco Bay from Yerba Buena Island south to the San Mateo Bridge. South of the bridge the western edge of the Niles Cone may form a permeability boundary along the rest of the length of the Bay. However, aquifer tests have shown hydraulic continuity of the Newark aquifer between the west end of the Dumbarton Bridge and wells on the east bay shore.
Sea-water Intrusion	Intrusion has been reported to have occurred in some shallow water wells during the 1930s before pumping there was discontinued. These instances of high salinity are now believed to have possibly originated from intrusion from tidal sloughs lying between San Mateo and Palo Alto to the south. Because the exact boundaries of these areas of degraded water are unknown, they do not appear in Figures 5 and 6. The great thickness of the bay mud along the shoreline prevents sea water from entering deep wells. At present, freshwater inflow to the Bay shoreline is probably sufficient to hold ground water levels at or above sea level and to maintain a bayward hydraulic gradient throughout the area.

San Mateo County
(Bay Shoreline)

GUADALUPE BASIN - BASIN 106

Location	At Brisbane, about 1.5 miles south of San Francisco.
Bibliography	Items 1, 21, 27, 28, 39. Pages 96-98.
Description	A small alluvium-filled valley extending 1.5 miles west from San Francisco Bay. Area: 0.4 square mile. Shoreline: about 2,700 feet.
Water Use	No observed use of surface or ground water by either the small industrial plant and the city of Brisbane located near the shore and the Bayshore freeway, or the Pacific Coast Aggregate Corporation quarry in the upper valley. Remainder of the valley is undeveloped.
Water-bearing Sediments	Unconsolidated Quaternary alluvium; physical characteristics are unknown. Water-bearing materials near Visitacion Point may extend about 100 feet below sea level at the shore.
Ground Water Barriers	None known.
Offshore Geology	Entire offshore area is underlain by mud whose greatest thickness exceeds 100 feet about one mile from shore.
Sea-water Intrusion	No information available. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and maintain a seaward hydraulic gradient throughout the basin.

San Francisco County
(Bay Shoreline)

VISITACION BASIN - BASIN 107

Location	Within the city limits of San Francisco.
Bibliography	Items 1, 21, 27, 28, 39. Pages 96-98.
Description	A wide alluvium-filled valley extending 1.5 miles west from San Francisco Bay. Area: about 1.3 square miles. Shoreline: about 1.25 miles.
Water Use	The San Francisco Water Department is the major source of water for numerous diversified industrial plants along the shore and for heavy urban and commercial development.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium. A pebbly sand and sand horizon, probably the Merritt sand, occurring at a depth of 50 to 60 feet, is overlain by bay mud and fill. Alluvium near the bay may extend about 250 feet below sea level.
Ground Water Barriers	The City College fault crossing Visitacion Valley may act as a partial barrier.
Offshore Geology	Entire offshore area is underlain by bay mud whose greatest thickness exceeds 100 feet about 1 to 2 miles offshore.
Sea-water Intrusion	No information available. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 63. MINERAL ANALYSIS, BASIN 107, VISITACION BASIN

Item	Well No. 2S/5W-33J
Date Sampled	1970
Chlorides (ppm)	38

San Francisco County
(Bay Shoreline)

POTRERO BASIN - BASIN 108

Location	Within the city limits of San Francisco, north of Candlestick Point.
Bibliography	Items 1, 21, 27, 28, 39. Pages 96-98.
Description	A narrow alluvium-filled valley extending 1.5 miles west of San Francisco Bay. Area: about 1.2 square miles. Shoreline: about 3,000 feet.
Water Use	The San Francisco Water Department is the major source of water for a completely developed area of diversified industry and scattered urbanization. Industry makes minor use of ground water.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium. A pebbly sand and sand horizon, probably the Merritt sand, occurring at a depth of 45 to 95 feet is overlain by bay mud and fill. Alluvium near the bay may reach 200 feet below sea level.
Ground Water Barriers	None known.
Offshore Geology	Entire offshore area underlain by bay mud whose greatest thickness exceeds 100 feet about 1 to 2 miles from shore.
Sea-water Intrusion	No information available in bayward portion of basin. Freshwater inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 64. MINERAL ANALYSES, BASIN 108, POTRERO

Item	Well No.			
	2S/5W-27	2S/5W-28G	2S/5W-28P	2S/5W-34F
Date Sampled	1970	1970	1970	1970
Chlorides (ppm)	50-80	64	124	82

San Francisco County
(Bay Shoreline)

ISLAIS BASIN - BASIN 109

Location	Within the city limits of San Francisco, south of Potrero Point.
Bibliography	Items 1, 21, 27, 28, 39. Pages 96-98.
Description	A broad alluvium-filled valley extending 1.3 miles west of San Francisco Bay. Area: about 1 square mile. Shoreline: about 1 mile.
Water Use	The San Francisco Water Department is the major source of water for the heavy development of diversified industries and scattered commercial and urban development. Industry makes minor use of ground water.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium. Two shallow pebbly sand and sand horizons overlain by bay mud and fill occur near the bay. An upper sand horizon, probably the Merritt sand, about 40 feet thick lies about 50 feet deep. Alluvium near the bay may reach 200 feet below sea level.
Ground Water Barriers	Hunter's Point shear zone across the valley mouth has an unknown effect on ground water movement.
Offshore Geology	Entire offshore area is underlain by bay mud whose greatest thickness exceeds 75 feet about 1 to 2 miles from shore.
Sea-water Intrusion	No information available for the area near the bay. The source of degraded ground water noted in the upper basin is unknown. Fresh-water inflow to the valley shore is probably sufficient to hold ground water at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 65. MINERAL ANALYSES, BASIN 109, ISLAIS

Item	Well No.	
	2S/5W-15N	2S/5W-16N
Date Sampled	1970	1970
Chlorides (ppm)	118	200

San Francisco County
(Bay Shoreline)

MARKET STREET BASIN - BASIN 110

Location	Within the city limits, in downtown San Francisco.
Bibliography	Items 1, 21, 27, 28, 39. Pages 96-98.
Description	A broad alluvium-filled valley and filled tideland area extending southwest from San Francisco Bay. Area: about 6 square miles. Shoreline: about 3.5 miles.
Water Use	The San Francisco Water Department is the major source of water for a total and heavy development of industry, commercial establishments, and residences. No use of surface water has been observed, but shallow alluvial wells serve for cooling and washing.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium, sand, and fill material. No well-defined continuous sand aquifers occur. Sediments of the bayward and middle portions of the valley are generally finer grained than those in the upper valley. Alluvium in a deep buried channel near the Ferry Building lies at least 277 feet below sea level. In the China Basin area to the south the alluvium may reach 200 feet below sea level.
Ground Water Barriers	None known.
Offshore Geology	Entire offshore area is underlain by bay mud whose greatest thickness exceeds 75 feet about 1 to 2 miles offshore.
Sea-water Intrusion	Degraded water was sampled near the bay in summer 1954 and in 1970. Chlorides in 1970 ranged from 106 to 360 ppm about 3,000 feet inland from the bay. These degraded areas could represent either native ground water quality or degradation by brackish water entering from former tidal marshlands now covered by manmade fill.

Table 66. MINERAL ANALYSES, BASIN 110, MARKET STREET

Item	Well No.								
	1S/5W-33G	2S/5W-3C2	2S/5W-3F1	2S/5W-3F1	2S/5W-4J	2S/5W-4N	2S/5W-16	2S/5W-20J	2S/5W-21E
Date Sampled	1970	1970	1954	1970	1970	1970	1970	1970	1970
Character	-	-	NaMgCl	-	-	-	-	-	-
Total Dissolved Solids (ppm)	-	-	1,430	-	-	-	-	-	-
Chlorides (ppm)	74	210	524	138	360	106	20-200	90	146

San Francisco County
(Bay Shoreline)

FORT MASON BASIN - BASIN 111

Location	Within the city limits of San Francisco in the North Beach area.
Bibliography	Items 1, 21, 27, 28, 39. Pages 96-98.
Description	A wide, shallow alluvium-filled valley extending 0.6 mile south from San Francisco Bay. Area: about 1.5 square miles. Shoreline: about 3 miles.
Water Use	The San Francisco Water Department is the major source of water for the area of total and heavy urban and commercial development. Fort Mason and the San Francisco Presidio military reservations occupy the eastern and western ends of the valley.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium and aeolian sand. An upper sand horizon extends 80 feet deep; a deep sand body about 20 feet thick occurs beneath a clay layer that lies 123 feet deep. Alluvium in a deep buried channel in the center of the valley lies about 250 feet below sea level.
Ground Water Barriers	None known.
Offshore Geology	Entire area is underlain by sand of unknown thickness.
Sea-water Intrusion	No evidence of degraded ground water on the basis of limited information available in the 1960s. No information available as of 1970-71. Fresh-water inflow to the valley shore is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 67. MINERAL ANALYSES, BASIN 111, FORT MASON

Item	Well No.		
	1S/5W-27	1S/5W-29	1S/5W-31
Date Sampled	1960s	1960s	1960s
Chlorides (ppm)	48-76	48-76	48-76

CHAPTER V

CENTRAL COASTAL BASINS

San Francisco County (Coastal)
San Mateo County (Coastal)
Santa Cruz County
Monterey County
San Luis Obispo County
Santa Barbara County

SAN FRANCISCO COUNTY (COASTAL)

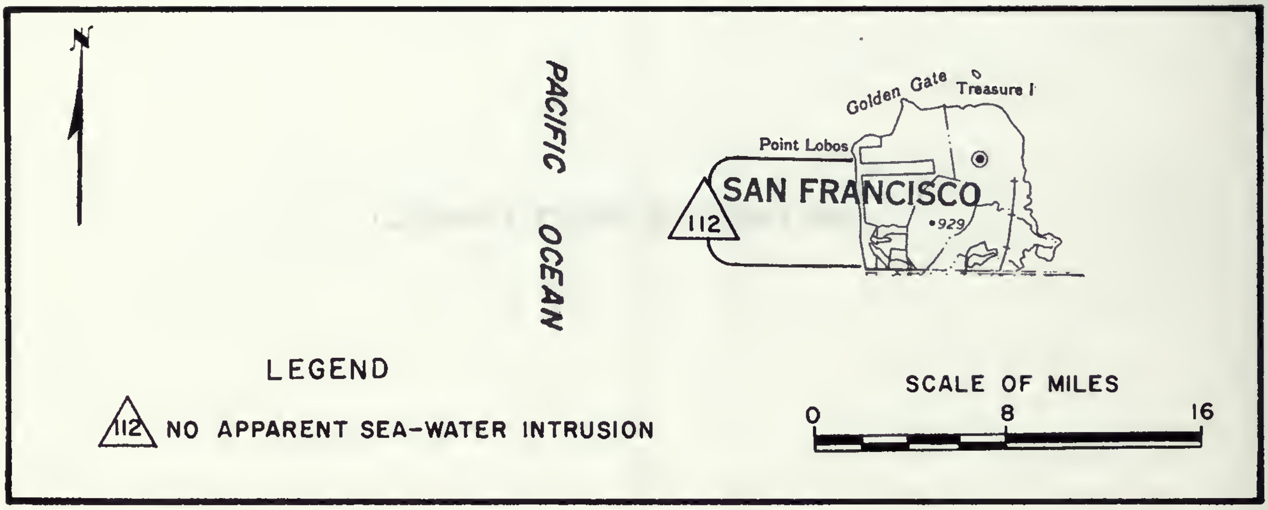


Figure 18. STATUS OF SEA—WATER INTRUSION, SAN FRANCISCO COUNTY (COASTAL) 1970—1971

SAN FRANCISCO COUNTY (COASTAL)

One large area of sand dunes has been identified as a source of ground water in coastal San Francisco County. Additional quantities of ground water are probably available in the Merced formation of Pliocene age, which may underlie the dune sands and which outcrops near Lake Merced. Estimates of ground water storage capacity are not available for the dunes or the Merced formation. The potential for fresh water storage in offshore aquifers is unknown.

Table 68. STATUS OF SEA-WATER INTRUSION, COASTAL SAN FRANCISCO COUNTY

Basin		1958	1970-71
No.	Name		
112	Merced Valley	No apparent sea-water intrusion	No change

BIBLIOGRAPHY

San Francisco County (Coastal)

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, San Francisco Sheet. 1961.

California Department of Water Resources

2. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23.

3. Status of Sea-Water Intrusion. December 1960. Pp. 96-97. (Unpublished; drafted as Appendix A of Bulletin No. 63)

4. Bulletin No. 130 Series, Hydrologic Data; Volume III, Appendixes C, D, and E. 1963-1971.

5. Bulletin No. 160-70, Water for California, The California Water Plan: Outlook for 1970. December 1970. 179 pages.

6. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

U. S. Geological Survey

7. Bedrock-Surface Map of the San Francisco North Quadrangle, California, and Bedrock-Surface Map of San Francisco South Quadrangle, California. San Francisco Bay Region. Environment and Resources Planning Study, Basic Data Contribution 26. 1964.

San Francisco County (Coastal)

MERCED VALLEY BASIN - BASIN 112

Location	From a point near Point Lobos south to the San Francisco-San Mateo County line.
Bibliography	Items 1, 3, 6, 7. Page 146.
Description	Broad sand dune area and older sediments overlying nonwater-bearing rock. Area: 10 square miles. Coastline: about 5 miles.
Water Use	Highly urbanized area occupied chiefly by the City of San Francisco and served almost entirely by imported water. Ground water levels during summer, 1954, were 60 feet below ground surface near Lake Merced and 16 feet below the surface near Point Lobos. Some ground water is used to irrigate parks and golf courses.
Water-bearing Sediments	Unconsolidated Recent sand dunes and some unconsolidated marine terraces to the south form the water-bearing materials, which in some instances have bases above sea level and in others may extend 300 feet below sea level. The Merced formation of Pliocene age outcrops in the Lake Merced area and may underlie a portion of this basin.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	None known.

Table 69. MINERAL ANALYSIS, BASIN 112, MERCED VALLEY

Item	Lake Merced
Character	$MgHCO_3$
Total Dissolved Solids (ppm)	Low
Chlorides (ppm)	<100

SAN MATEO COUNTY (COASTAL)

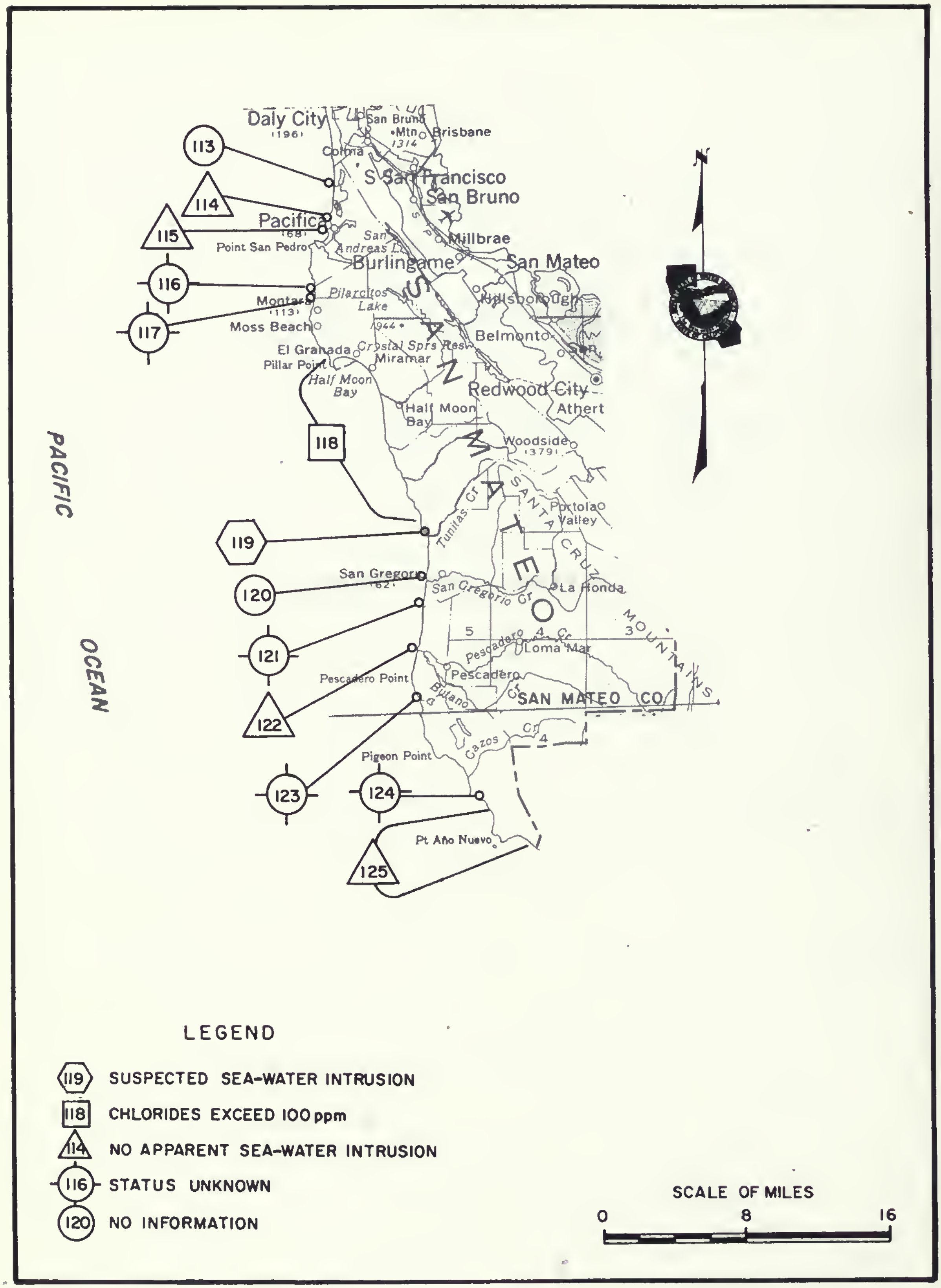


Figure 19. STATUS OF SEA-WATER INTRUSION, SAN MATEO COUNTY (COASTAL) 1970-1971

SAN MATEO COUNTY (COASTAL)

The 13 identified ground water basins in coastal San Mateo County are made up of nine valley-fill areas and four dune-covered marine terraces. Together they cover about 24.6 square miles and are open to the Pacific Ocean along about 21 miles.

Basin 118, the largest area, is an 11-square-mile tilted marine terrace incised by several alluvium-filled valleys. Additional quantities of ground water may be available in the Merced formation of Pliocene age that underlies and flanks some of the small alluvial valleys. No estimates of ground water storage capacity are available for the valleys, the marine terraces, or the Merced formation. The potential for fresh water storage in offshore aquifers is unknown but it is probably negligible or nonexistent.

Limited quantities of ground water for domestic use may be obtainable from the Montara (Mesozoic age) granitic rock mass north of Half Moon Bay and from Tertiary sedimentary rocks in the central and southern parts of the county, where water is confined to joints, fractures, and weathered areas. The amounts of water available are generally small. These areas were excluded from the statewide inventory.

Table 70. STATUS OF SEA-WATER INTRUSION, COASTAL SAN MATEO COUNTY

Basin		1953-55	1970-71
No.	Name		
113	Sharp Park Terrace	Chlorides exceed 100 ppm	No information
114	Calera	No apparent sea-water intrusion	No change
115	San Pedro	No apparent sea-water intrusion	No change
116	Montara Terrace	Status unknown	Status unknown
117	Montara Point	Status unknown	Status unknown
118	Half Moon Bay Terrace	Chlorides exceed 100 ppm	No change
119	Tunitas Creek	Status unknown	Suspected sea-water intrusion
120	San Gregorio Creek	Chlorides exceed 100 ppm	No information
121	Pomponio	Status unknown	Status unknown
122	Pescadero	No apparent sea-water intrusion	No change
123	Los Frijoles	Status unknown	Status unknown
124	White House Creek	Status unknown	Status unknown
125	Ano Nuevo Terrace	Status unknown	No apparent sea-water intrusion

BIBLIOGRAPHY

San Mateo County (Coastal)

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, San Francisco Sheet. 1961.

California Department of Water Resources

2. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23.

3. Status of Sea-Water Intrusion. December 1960. Pp. 97-109. (Unpublished; drafted as Appendix A of Bulletin No. 63).

4. Bulletin No. 130 Series, Hydrologic Data; Volume III, Appendixes C, D, and E. 1963-1971.

5. Bulletin No. 138, Coastal San Mateo County Investigation. March 1966. Pp. 77-82.

6. Bulletin No. 160-70, Water for California, the California Water Plan: Outlook in 1970. December 1970. 179 pages.

7. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

San Mateo County (Coastal)

SHARP PARK TERRACE - BASIN 113

Location	10 miles south of San Francisco.
Bibliography	Items 1, 3, 7. Page 152.
Description	Dune-covered marine terrace area extending along the coast from Mussel Rock to Salt Valley. Area: about 1.2 square miles. Coastline: about 3 miles.
Water Use	Rapid urbanization of the entire area centers around the small towns of Edgemar and Sharp Park. A large golf course occupies the southern part of the basin and some stock is grazed in the inland portion. The extent of ground water use is unknown.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary sand dunes, alluvium, and marine terrace deposits. Physical characteristics or thickness of the Quaternary deposits cannot be determined because well logs are lacking. Some of the large alluvium-filled valleys, such as Salt Valley, may be entrenched in the marine terrace deposits to depths below sea level. The entire coastal portion of this basin is covered by dune sand.
Ground Water Barriers	None known.
Sea-water Intrusion	No information was available as of 1970. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin. Sea-water intrusion is no threat to the northern part of the terrace because the base of unconsolidated water-bearing marine terrace deposits rests on consolidated bedrock at or above sea level. Dune sand covering the central and coastal part of the terrace obscures the relationship of the base of these deposits to sea level. In November 1947, an area of degraded ground water existed in the coastal part of the basin.

Table 71. MINERAL ANALYSES, BASIN 113, SHARP PARK TERRACE

Item	Milagra Creek (1953)	Salt Valley Creek	Laguna Salada	Well No. 3S/6W-26C (1947)
Character	$MgHCO_3$	$MgHCO_3$	NaCl	MgCl
Total Dissolved Solids (ppm)	310	231	2,040	--
Chlorides (ppm)	61	36	1,040	145

San Mateo County (Coastal)

CALERA BASIN - BASIN 114
SAN PEDRO BASIN - BASIN 115
MONTARA TERRACE - BASIN 116
MONTARA POINT BASIN - BASIN 117

Location	Extends for seven miles from Sharp Park area south to Montara Point area.
Bibliography	Items 1, 2, 3, 5, 7. Page 152.
Description	A short coastal area of moderate relief consisting of three small alluvium-filled valleys and one dune-covered marine terrace. Combined area of valleys and terrace: 2.4 square miles. Total coastline: 7,700 feet.
Water Use	The coastal area is changing from range land and small farms to residences and resorts. Ground and surface water have undergone limited development for domestic and agricultural use and for livestock. The extent of ground water use is unknown.
Water-bearing Sediments	Unconsolidated alluvium and marine terrace deposits of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No evidence of intrusion in Basins 114 and 115. No information is available for Basins 116 and 117. Fresh-water inflow to all basins is probably sufficient to maintain a seaward hydraulic gradient.

San Mateo County (Coastal)

HALF MOON BAY TERRACE - BASIN 118

Location	About 20 miles south of San Francisco.
Bibliography	Items 1, 3, 5, 7. Page 152.
Description	An extensive tilted marine terrace extending from Moss Beach south to Martins Beach and one mile inland from the coastal town of Half Moon Bay (its widest point). The area includes eight narrow alluvium-filled valleys extending east from the terrace. The base of the unconsolidated terrace deposits in the northernmost six miles of coastline is obscured by beach deposits, but it is believed to lie below sea level and is thus open to the ocean. Combined area of the valleys: $3\frac{1}{2}$ square miles. Area of the basin: 11 square miles. Coastline: about 14 miles.
Water Use	Many small farms and sections of urban and commercial development lie in and near the communities of Half Moon Bay, El Granada, Moss Beach, and Princeton. Residential and resort development is occurring rapidly. Much of the terrace is occupied by artichoke and brussel sprout culture and some of it by stock grazing. Surface water is used for irrigation and stockwatering. Numerous wells in the northern and central parts of the terrace supply water for domestic use and for irrigation. The terrace lies entirely within the service area of the Coastside County Water District, which imports water from Hetch Hetchy Reservoir.
Water-bearing Sediments	The principal sources of ground water are the sand and gravel horizons that lie at depths of 20 to 80 feet in the unconsolidated Quaternary marine terrace deposits and in unconsolidated Quaternary alluvium that occurs in channels entrenched in the marine terrace deposits. Limited quantities of ground water may also occur in the underlying Purisima formation of Pliocene age.
Ground Water Barriers	None known.
Offshore Geology	The entire northern portion of Half Moon Bay is underlain by sand and silt. Fine sands of the beach area extend into the bay approximately 100 yards to a depth of 10 to 15 feet. Very fine sands occur to depths of 20 to 30 feet, pebbles and sand, to depths of 40 feet, and silt and more consolidated rock (probably the Merced formation), at 50 feet. A barrier reef of consolidated Merced sediments that outcrops on the bay floor about $1\frac{1}{2}$ miles offshore marks the approximate outer limit of unconsolidated Quaternary deposits beneath the bay. No information is available concerning the location, extent, and physical characteristics of sediments in the central and southern portion of Half Moon Bay.

Sea-water Intrusion — Several wells having degraded ground water are assumed to reflect local ground water conditions, not sea-water intrusion. Neighboring wells show no degradation.

Table 72. MINERAL ANALYSES, BASIN 118, HALF MOON BAY TERRACE

Item	Surface Water					Ground Water	
	Frenchman Creek	Pilarcitas Creek	Denniston Creek	San Vicente Creek	Purisima Creek	Well No. 5S/5W-18P1 (1953)	Well No. 5S/5W-19G1 (1953)
Character	$NaHCO_3$	$CaHCO_3$	$CaNaHCO_3$	$NaHCO_3$	$CaHCO_3$	NaCl	$NaHCO_3$
Total Dissolved Solids (ppm)	154	292	151	157	318	584	318
Chlorides (ppm)	32	46	31	38	31	230	64

Item	Ground Water						
	Well No. 5S/5W-19H (1970)	Well No. 5S/5W-30A (1954)	Well No. 5S/5W-32K1 (1953)	Well No. 5S/6W-11E (1970)	Well No. 5S/6W-11E2 (1970)	Well No. 5S/6W-11Q1 (1953)	Well No. 6S/5W-8A1 (1953)
Character	--	NaCl	NaCl	--	--	NaCl	NaCl
Total Dissolved Solids (ppm)	--	460	597	--	--	379	1,740
Chlorides (ppm)	60	112	129	80	80	93	715

San Mateo County (Coastal)

TUNITAS CREEK BASIN - BASIN 119

Location	7 miles south of Half Moon Bay.
Bibliography	Items 1, 3, 5, 7. Page 152.
Description	A narrow alluvium-filled valley extending 2 miles northeast from the coast. The valley is formed mainly of an elevated stream terrace with a narrow segment of alluvium lying in a deeply incised stream channel. Area: about 0.5 square mile. Coastline: about 300 feet.
Water Use	The elevated terrace is cultivated to artichokes and brussel sprouts. Several ranches are scattered about the valley. No development has taken place near Tunitas Creek. Surface water, springs, and several wells supply local water needs.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium, including stream channel deposits and older elevated stream terrace deposits. No well logs are available to provide information on physical characteristics or thickness of the alluvium. Limited quantities of ground water may occur in the adjacent and underlying Purisima formation of Pliocene age.
Ground Water Barriers	None known.
Sea-water Intrusion	The amount of chlorides found in 1970 in two wells adjacent to Tunitas Creek indicates sea-water intrusion is occurring in the lower valley.

Table 73. MINERAL ANALYSES, BASIN 119, TUNITAS CREEK

Item	Tunitas Creek	Well No. 6S/5W-33R (1970)	Well No. 7S/5W-4A (1970)
Character	$NaHCO_3$	--	--
Total Dissolved Solids (ppm)	353	--	--
Chlorides (ppm)	58	1,560	340

(San Mateo County (Coastal)

SAN GREGORIO CREEK BASIN - BASIN 120

Location	About 10 miles south of Half Moon Bay.
Bibliography	Items 1, 3, 5, 7. Page 152.
Description	A narrow alluvium-filled valley extending east 6 miles from the coast. Area: about 1.25 miles. Coastline: about 400 feet.
Water Use	The entire valley is developed to irrigated truck crops and to natural and irrigated pasture. Surface water and shallow wells supply local domestic, irrigation, and livestock watering needs.
Water-bearing Sediments	Ground water generally occurs in sand and gravel horizons lying 25 to 50 feet deep in unconsolidated Quaternary alluvium. No well logs are available to show thickness of the alluvium or its physical characteristics below 50 feet. Limited quantities of ground water may occur in the adjacent and underlying Purisima formation of Pliocene age.
Ground Water Barriers	No information is available to show whether the San Gregorio fault that crosses the lower end of the valley about 0.5 mile inland forms a barrier to ground water movement.
Sea-water Intrusion	Several areas of degraded ground water that were sampled near the coast in summer, 1953, probably represent natural conditions in the alluvium and underlying Purisima formation rather than sea-water intrusion. No information was available in 1970. A few wells were tested for chlorides in 1973.

Table 74. MINERAL ANALYSES, BASIN 120, SAN GREGORIO CREEK

Item	San Gregorio Creek	Well No. 7S/5W-14H1	Well No. 7S/5W-15C1	Well No. 7S/5W-15E2	Well No. 7S/5W-15E1	Well No. 7S/5W-15B1
Date Sampled	-	1953	1953	1973	1973	1973
Character	$CaHCO_3$	NaCl	$NaHCO_3$	-	-	-
Total Dissolved Solids (ppm)	364	1,690	622	-	-	-
Chlorides (ppm)	42	655	138	172	244	288

San Mateo County (Coastal)

POMPONIO BASIN - BASIN 121
PESCADERO BASIN - BASIN 122
LOS FRIJOLES BASIN - BASIN 123
WHITE HOUSE CREEK BASIN - BASIN 124
ANO NUEVO TERRACE - BASIN 125

Location	In the southern part of the county, extending 16 miles from Pomponio Creek south to the boundary with Santa Cruz County.
Bibliography	Items 1, 3, 5, 7. Page 152.
Description	An area of moderate relief consisting of four alluvium-filled valleys and one large dune-covered marine terrace. Area of valleys and terrace: 8.25 square miles. Coastline: 13,000 feet.
Water Use	Moderate to limited development of surface and ground water for domestic, agricultural, and stockwatering uses.
Water-bearing Sediments	Unconsolidated alluvium and one extensive marine terrace deposit of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	Sampling taken in 1953, 1954, and 1970 indicated no degraded ground water in Basin 122. Sampling taken in 1970 indicated no degraded ground water in Basin 125, but a 1973 sample indicated that chlorides had doubled. No information was available for Basins 121, 123, and 124. Fresh-water inflow to all basins is probably sufficient to maintain a seaward hydraulic gradient.

Table 75. MINERAL ANALYSES, BASINS 121-125, POMPONIO, PESCADERO, LOS FRIJOLES, AND WHITE HOUSE CREEKS, AND ANO NUEVO TERRACE

Item	Basin 121	Basin 122							
	Pomponio Creek	Pescadero Creek		Butano Creek	Well No. 8S/5W-10E2	Well No. 8S/5W-10F1		Well No. 8S/5W-10F2	Well No. 8S/5W-11E1
		Tidal area	Inland						
Date Sampled	-	-	-	-	1952	1970	1973	1970	1954
Character	$NaSO_4$	NaCl	$CaHCO_3$	$CaHCO_3$	$CaNaHCO_3SO_4$	-	-	-	$MgHCO_3$
Total Dissolved Solids (ppm)	256	2,170	348	206	457	-	-	-	-
Chlorides (ppm)	44	1,080	33	24	69	60	140	60	41

Item	Basin 123			Basin 124		Basin 125			
	Lake Lucerne	Well No. 8S/5W-21E		White House Creek	Well No. 8S/5W-12D	Cascade Creek	Green Oaks Creek	Ano Nuevo Creek	Well No. 9S/4W-28D
Date Sampled	-	1970	1973	-	1970	-	-	-	1970
Character	NaCl	-	-	$NaSO_4$	-	$NaSO_4$	$NaSO_4$	$NaSO_4$	-
Total Dissolved Solids (ppm)	187	-	-	169	-	203	193	212	-
Chlorides (ppm)	49	2,360	224	26	40	28	32	30	50

SANTA CRUZ COUNTY

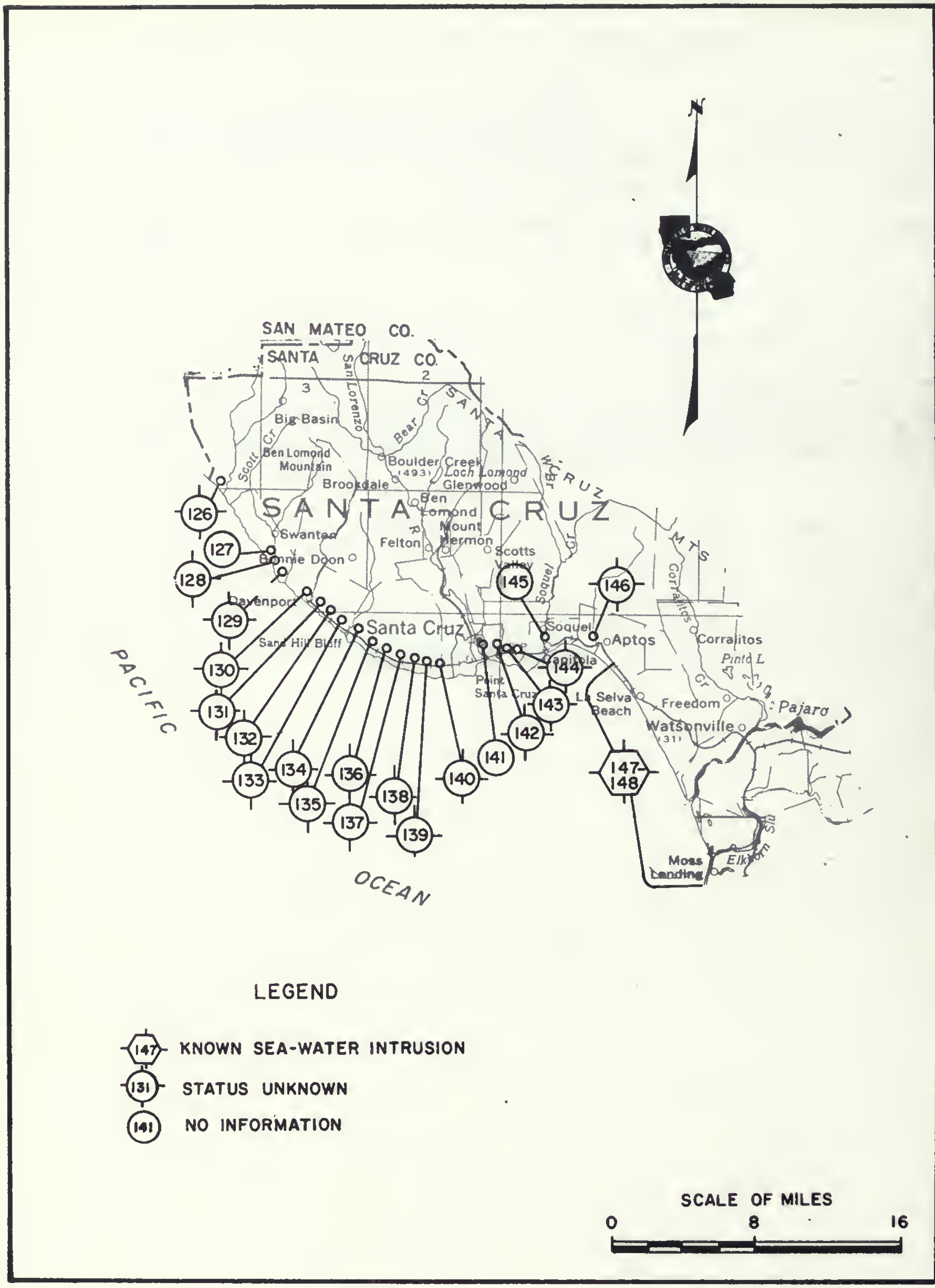


Figure 20. STATUS OF SEA—WATER INTRUSION, SANTA CRUZ COUNTY 1970-1971

The 22 identified ground water basins in coastal Santa Cruz County lie in valley-fill areas. They cover about 110 square miles and are open to the Pacific Ocean along 11 to 15 miles of coastline.

The major coastal ground water area, which comprises Basins 147 and 148, is identified as the Pajaro Valley Area. Pajaro Valley occupies portions of both Santa Cruz and Monterey Counties. Because the greater part of it lies within Santa Cruz County, Pajaro Valley is included in the coastal Santa Cruz County discussion. The valley occupies an area of about 100 square miles; about 45 square miles of this is underlain by valley-fill materials. Older water-bearing sediments, such as the Aromas red sands, flank the alluvial-fill materials in the valley floor. Each of the remaining valleys contains generally less than 1 square mile.

Additional quantities of ground water may be available in the numerous shallow marine terraces that flank the small alluvium-filled valleys in the area north of the City of Santa Cruz. Recent studies indicate that portions of the Aromas red sands of Pleistocene age and the upper portions of the Purisima formation of Pliocene age situated south of the City of Santa Cruz may yield considerable quantities of water to wells.

The upper sandy units of the Purisima formation in the coastal Soquel-Aptos area are estimated to store about 800,000 acre-feet of ground water. This is the only estimate of ground water storage capacity for coastal Santa Cruz County. The potential for fresh water stored in offshore aquifers beneath the northern portion of Monterey Bay may be as great as that indicated by preliminary U.S.G.S. studies of the south Monterey Bay area. The potential for ground water stored in the small valleys north of Santa Cruz is unknown, but it is probably negligible or nonexistent.

Limited quantities of ground water for domestic use may be obtainable from the Tertiary sedimentary rocks and isolated marine terrace deposits that lie along the coast north of the City of Santa Cruz. Water supplies in these materials are generally small. These areas were excluded from this statewide inventory.

Table 76. STATUS OF SEA-WATER INTRUSION, SANTA CRUZ COUNTY

Basin No.	Basin Name	1953-1955	1970-71
126	Waddell	Status unknown	Status unknown
127	Scott Creek	Chlorides exceed 100 ppm	No information
128	Molino Creek	Status unknown	Status unknown
129	Davenport Landing	Status unknown	Status unknown
130	San Vicente Creek	Status unknown	Status unknown
131	Liddell Creek	Status unknown	Status unknown
132	Respini Creek	Status unknown	Status unknown
133	Laguna Creek	Status unknown	Status unknown
134	Majors Creek	Status unknown	Status unknown
135	Baldwin Creek	Status unknown	Status unknown
136	Needle Rock	Status unknown	Status unknown
137	Sandy Flat	Status unknown	Status unknown
138	Meder Creek	Status unknown	Status unknown
139	Terrace	Status unknown	Status unknown
140	Moore Creek	Status unknown	Status unknown
141	San Lorenzo River	No apparent sea-water intrusion	No information
142	Arana Gulch	Status unknown	Status unknown
143	Schwans Lagoon	Status unknown	Status unknown
144	Doyle	Status unknown	Status unknown
145	Soquel	No apparent sea-water intrusion	No information
146	Valencia Creek	Status unknown	Status unknown
147*	Pajaro Valley	Known sea-water intrusion	Area increasing
148*	Elkhorn Slough Area	Known sea-water intrusion	Area increasing

*Basins 147 and 148 combined under Pajaro Valley Area

BIBLIOGRAPHY

Santa Cruz County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, Santa Cruz Sheet. 1958.

2. Geologic Map of California, San Francisco Sheet. 1961.

California Department of Water Resources

3. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23 and Plate 10.

4. Status of Sea-Water Intrusion. December 1960. Pp. 110-125. (Unpublished; drafted as Appendix A of Bulletin No. 63).

5. Bulletin No. 66, Quality of Ground Waters in California, 1957. April 1960. Plate 3.

6. Bulletin No. 66-58, Quality of Ground Waters in California, 1958. November 1960. Plate 3.

7. Bulletin No. 66-59, Quality of Ground Waters in California, 1959; Part I, Northern and Central California. July 1961. P. 106.

8. Bulletin No. 66-60, Quality of Ground Waters in California, 1960; Part I, Northern and Central California. March 1964. Plate 9.

9. Bulletin No. 66-62, Quality of Ground Waters in California, 1961 and 1962; Part 1, Northern and Central California. August 1964. Plate 9.

10. Bulletin No. 67, Reclamation of Water from Sewage and Industrial Wastes: Watsonville Area, Santa Cruz and Monterey Counties. August 1959. 66 pages.

11. Bulletin No. 130 Series, Hydrologic Data; Volume III, Appendixes C, D, and E. 1963 through 1971.

12. Bulletin No. 143-1, San Lorenzo River Watershed Water Quality Investigation. June 1966. 180 pages.

13. Bulletin No. 160-70, Water for California, the California Water Plan: Outlook in 1970. December 1970. 179 pages.

14. Special Investigation--Pajaro River Basin. Memorandum Report to the Central Coastal Regional Water Quality Control Board. June 1968.

15. Special Investigation--Salinas River Basin. Memorandum Report to the Central Coastal Regional Water Quality Control Board. January 1969.

16. Sea-Water Intrusion, Lower Salinas Valley. Progress Report 1968-69. June 1970. 28 pages.

17. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

18. Special Investigation--Monterey County Coastal Drainage Basins. Memorandum Report to the Central Coastal Regional Water Quality Control Board. October 1971.

19. Sea-Water Intrusion, Lower Salinas Valley, Monterey County. District Report. San Joaquin District. July 1973. 91 pages.

California State Water Resources Control Board

20. Bulletin No. 5 and Appendix B, Santa Cruz-Monterey Counties Investigation. August 1953. Pp. 18, 29-42, 45, 81-83, B91-9102.

U. S. Geological Survey

21. Ackers, J. B., and J. J. Hickey. Geohydrologic Reconnaissance of the Soquel-Aptos Area, Santa Cruz County, California. U. S. Geological Survey, Water Resources Division. March 28, 1967. 58 pages.

22. Hickey, J. J. Hydrogeologic Study of the Soquel-Aptos Area, Santa Cruz County, California. U. S. Geological Survey, Water Resources Division. Open File Report. 1968. 48 pages.

23. Bader, J. S. Ground Water Data as of 1967, Central Coastal Subregion, California. U. S. Geological Survey, Water Resources Division. Open File Report. March 5, 1969. Pp. 6-7.

24. Geology of Southern Monterey Bay and Its Relationship to the Ground Water Basin and Salt Water Intrusion. Open File Report, in cooperation with Department of Water Resources. 1970.

Miscellaneous

25. Dill, R. F., R. S. Dietz, and H. Stewart. Deep-Sea Channel of the Monterey Canyon. Bulletin of the Geological Society of America. Vol. 65, No. 2. 1954.

26. Monterey County Flood Control and Water Conservation District. Basic Data and Operation Report--Hydrology, Ground Water and Climatology. Annual Report for Water Years 1958 through 1969.

Santa Cruz County

WADDELL BASIN - BASIN 126

Location	16 miles northwest of the City of Santa Cruz.
Bibliography	Items 2, 4, 17. Page 165-166.
Description	A narrow alluvium-filled valley extending 2.2 miles northeast from the coast. Area: about 0.3 square mile. Coastline: about 1,800 feet.
Water Use	Entire valley is used for stock grazing and uses surface water. There is no observed development of ground water.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium. No well logs are available that indicate physical characteristics and thickness of alluvium.
Ground Water Barriers	None known.
Sea-water Intrusion	No information available. Fresh-water inflow to coastal segment of the valley is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 77. MINERAL ANALYSIS, BASIN 126, WADDELL

	Waddell Creek
Character	NaCl
Total Dissolved Solids (ppm)	1,150
Chlorides (ppm)	550

Santa Cruz County

SCOTT CREEK BASIN - BASIN 127

Location	About 12 miles northwest of the City of Santa Cruz.
Bibliography	Items 2, 4, 17. Page 165-166.
Description	A narrow alluvium-filled valley extending about 6 miles north from the coast. Area: about 0.75 square mile. Coastline: about 1,800 feet.
Water Use	The entire valley, except for an area near a coastal lagoon, is developed to scattered truck farms whose crops are irrigated by surface water (to a limited extent) and by water from shallow wells. These wells also supply water for domestic use. General Petroleum Corporation maintains an oil loading and storage facility at the mouth of Scott Creek.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium. No well logs are available that indicate the physical characteristics and thickness of the alluvium.
Ground Water Barriers	None known.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal segment of this basin as of summer 1953. At that time, in an area about a half mile inland, chlorides were about 10 times greater and boron was about 190 times greater, in ground water than in surface water. Source of this degraded ground water may have been intrusion of brackish or saline waters. No information was available for 1970.

Table 78. MINERAL ANALYSES, BASIN 127, SCOTT CREEK

	Scotts Creek	Well No. 10S/3W-20M1 (1953)
Character	NaCl	$NaClHCO_3$
Total Dissolved Solids (ppm)	156	1,440
Chlorides (ppm)	38	455

MOLINO CREEK BASIN	BASIN 128	BALDWIN CREEK BASIN	BASIN 135
DAVENPORT LANDING BASIN	BASIN 129	NEEDLE ROCK BASIN	BASIN 136
SAN VICENTE CREEK BASIN	BASIN 130	SANDY FLAT BASIN	BASIN 137
LIDDELL CREEK BASIN	BASIN 131	MEDER CREEK BASIN	BASIN 138
RESPINI CREEK BASIN	BASIN 132	TERRACE BASIN	BASIN 139
LAGUNA CREEK BASIN	BASIN 133	MOORE CREEK BASIN	BASIN 140
MAJORS CREEK BASIN	BASIN 134		

Location — In central part of the county, extending for 15 miles from Molino Creek south nearly to the City of Santa Cruz

Bibliography — Items 1, 2, 4, 17. Page 165-166.

Description — An extensive coastal marine terrace area of low relief incised by 13 small alluvium-filled valleys. Area of valleys: 1.75 square miles. Coastline: 7,250 feet.

Water Use — Truck crops and pasture for stock grazing occupy a large part of the area. Ground water has undergone limited development. Most of the region lies within the service area of the Santa Cruz City Water Department.

Water-bearing Sediments — The valleys contain unconsolidated alluvium of unknown thickness and physical characteristics. Sea water is prevented from intruding the water-bearing marine terrace deposits that flank many of the small valleys because the base of these materials lies above sea level.

Ground Water Barriers — None known.

Offshore Geology — No information available.

Sea-water Intrusion — No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 79. MINERAL ANALYSES, BASINS 128, 130-135, AND 138, MOLINO CREEK, SAN VICENTE CREEK LIDDELL CREEK, RESPINI CREEK, LAGUNA CREEK, MAJORS CREEK, BALDWIN CREEK, AND MEDER CREEK

Item	Basin 128 Molino Creek	Basin 130 San Vicente Creek	Basin 131 Liddell Creek	Basin 132 Respini Creek	Basin 133 Laguna Creek	Basin 134 Majors Creek	Basin 135 Baldwin Creek	Basin 138 Meder Creek
Character	$NaHCO_3$	$CaHCO_3$	$CaHCO_3$	$NaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$
Total Dissolved Solids (ppm)	202	166	266	271	236	234	230	279
Chlorides (ppm)	35	13	25	38	22	21	32	28

SAN LORENZO RIVER BASIN - BASIN 141

Location	Within the boundaries of the City of Santa Cruz.
Bibliography	Items 1, 4, 12, 17, 20, 23. Page 165-166.
Description	A branching alluvium-filled valley extending 4 miles north from the coast. Area: about 3 square miles. Coastline: about 3,300 feet.
Water Use	Urban and commercial development in the City of Santa Cruz occupies the coastal half of the valley; scattered homes, a few orchards, and campgrounds occupy the inland half of the valley. All water needs are met by the Santa Cruz City Water Department, which uses both surface and ground water.
Water-bearing Sediments	Present ground water supplies are derived from sand and gravel deposits that lie from 30 to 100 feet deep in unconsolidated Quaternary alluvium. No well logs are available that indicate the thickness or physical characteristics of the deeper portions of the alluvium. The Purisima formation of Pliocene age apparently underlies portions of the coastal area and may contain fresh water.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	Limited data available in the summer of 1954 gave no evidence of sea-water intrusion or degraded ground water in the coastal segment of this basin. Department of Water Resources' Bulletin No. 143-1 (1966) reported that the three wells of the City of Santa Cruz near the check dam where surface water is pumped from the San Lorenzo River have on occasions of heavy pumping caused sea water to intrude into the aquifer. The result has been chloride concentrations that exceed 1,000 ppm in water from these wells. The wells are reportedly kept on a standby status. No information was available in 1970. Under most conditions, fresh-water inflow to the coastal part of the valley is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 80. MINERAL ANALYSES, BASIN 141, SAN LORENZO RIVER

	San Lorenzo River	Well No. 11S/2W-12F1
Character	$CaHCO_3$	$CaHCO_3$
Total Dissolved Solids (ppm)	190	240
Chlorides (ppm)	14	25

Santa Cruz County

ARANA GULCH BASIN - BASIN 142
SCHWANS LAGOON BASIN - BASIN 143
DOYLE BASIN - BASIN 144
SOQUEL BASIN - BASIN 145
VALENCIA CREEK BASIN - BASIN 146

Location	Extends for about 6 miles from near the City of Santa Cruz south to Valencia Creek near the community of Aptos.
Bibliogra	Items 1, 4, 17, 20, 21, 22, 23. Page 165-166.
Description	A coastal marine terrace of low relief incised by 5 small alluvium-filled valleys. Area of 5 small valleys: 3.5 square miles. Coastline of 5 small valleys: 3,450 feet.
Water Use	An area of rapidly growing residential and resort development and a limited amount of farming and stock grazing that is located within the service area of the Santa Cruz City Water Department and several water companies.
Water-bearing Sediments	The Purisima formation of Pliocene age, which underlies the entire area at a considerable depth, appears to be the major source of ground water in the area. The upper sandy members of this formation appear to extend to depths of about 375 feet below sea level near the coast and yield the most water to wells. Overlying the Purisima formation are 5 small alluvium-filled valleys. The alluvium is shallow and not highly permeable and its base lies below sea level at the coast. Flanking these valleys and overlying the Purisima formation is an extensive shallow, low-permeability, water-bearing marine terrace whose base is above sea level. Ground water in storage in the upper sandy units of the Purisima formation near the coast may be about 800,000 acre-feet. There is no estimate of ground water in storage or of ground water storage capacity for the small alluvial valleys or the marine terrace.
Ground Water Barriers	None known.
Offshore Geology	The Purisima formation extends offshore beneath Monterey Bay. The exact position of the outcrop is unknown, but hydraulic gradients suggest that it may lie fairly close to the coast. No information is available to show the location of the offshore extension of the alluvial valleys.
Sea-water Intrusion	No information was available in 1970 that indicates sea water was intruding into the small alluvium-filled valleys. Encroachment of salt water in the offshore extension of the Purisima formation is a possibility, if the draft on the coastal onshore aquifers

Sea-water Intrusion (Cont.) increases. The salt water wedge in the Purisima formation is located at some unknown but possibly close position offshore.

Table 81. MINERAL ANALYSES, BASINS 142-146, ARANA GULCH, SCHWANS LAGOON, DOYLE, SOQUEL, AND VALENCIA CREEK

Item	Soquel Creek		Well No. 11S/1W-10Q2 (1951)	Well No. 11S/1W-15J1 (1951)
	4/55	8/70		
Character	$CaHCO_3$	-	$CaHCO_3$	$CaHCO_3$
Total Dissolved Solids (ppm)	Moderate	439	Moderate	Moderate
Chlorides (ppm)	19	66	56	48

PAJARO VALLEY AREA - BASINS 147 AND 148*

Location	18 miles north of the City of Monterey, lying in both Santa Cruz and Monterey Counties.
Bibliography	Items 1, 4, 5, 6, 7, 8, 9, 14, 16, 20, 22, 24, 26. Page 165-166.
Description	An extensive alluvial plain with channel and terrace deposits that is flanked by older, slightly compacted water-bearing materials. Area of valley floor materials: about 45 square miles. Area of entire basin, including older water-bearing sediments: about 100 square miles. Coastline: about 8 to 10 miles.
Water Use	Ground water is used for irrigation, industry, and municipalities. The valley fill area is developed to truck crops and orchards.
Water-bearing Sediments	Water occurs in three distinct zones in Quaternary deposits in the Pajaro River Valley floor: shallow, intermediate, and deep. All three zones are well defined, composed of sands, with some small gravels, and separated by blue clay layers. The shallow zone lies less than 100 feet deep and contains unconfined, semiperched water. The intermediate zone, which is the main pumping zone, lies at depths of 100 to 300 feet, and the ground water it contains is generally confined. This zone is probably exposed on the ocean floor in the Monterey Submarine Canyon about 5 miles offshore. The deep zone, about 800 feet deep, also contains confined ground water and apparently consists of well defined aquifers and aquicludes. Total ground water storage capacity has not been estimated. Flanking and underlying the alluvium is a thick section of water-bearing Aromas Red Sands of Pleistocene age and the Purisima formation of Pliocene age. Total ground water storage capacity of these materials has not been estimated.
Ground Water Barriers	No known barriers exist to inland movement of sea water. North-south lateral movement of ground water is prevented by gorge fill deposits in the inland extension of the Monterey Canyon. This barrier extends inland under the lower reach of Elkhorn Slough and separates the ground water basin of the Pajaro Valley Area from the Salinas Valley pressure area. The northern boundary of Pajaro Valley, not clearly defined, may simply merge with the older water-bearing materials in the Soquel-Aptos area.
Offshore Geology	Detailed offshore studies by the U. S. Geological Survey in southern Monterey Bay have defined the offshore outcrop of the 180-foot and 400-foot aquifers, which are the principal water-bearing sediments in the Salinas Valley immediately south of Pajaro Valley. Future investigation of the bay north of Monterey Canyon will, it is believed, identify a similar area of contact with the ground water aquifers of the Pajaro Valley Area.

* Elkhorn Slough Area, Basin 148, has been combined with Pajaro Valley, Basin 147.

Sea-water Intrusion	Intrusion in the main (intermediate) pumping zone was first reported in the early 1940s. The first detailed studies of the area, conducted during the summer of 1947, found chloride concentrations in wells as far inland as one mile were excessively high in relation to the quality of native ground water. The chloride front of over 100 ppm chlorides had advanced about 1.4 miles inland by 1962 and about 1.6 miles inland by 1970.

Table 82. MINERAL ANALYSES, BASINS 147 and 148, PAJARO VALLEY AREA

Item	Surface Water		Ground Water	
	Pajaro River	Elkhorn Slough	Wells	
Location Number	12S/02E-18P	12S/02E-27L	12S/01E-03B1	12S/01E-23R1
Date Sampled	7-25-70	3-4-70	7-24-70	9-26-68
Temperature (°F)	67	-	71	-
Specific Conductance (Micromhos @ 25° C)	1,780	526	364	625
pH	8.2	7.4	8.2	8.4
Percent Sodium	-	-	32	-
CONSTITUENTS in milligrams per liter (mg/l) / in milliequivalents per liter (meq)				
Total Dissolved Solids[1]	-	350	-	-
Hardness as $CaCO_3$				
Total	565	164	118	201
Noncarbonate	-	48	44	-
Bicarbonate: HCO_3	495 8.11	142 2.33	90 1.48	298 4.89
Boron	-	0.1 -	0.0 -	-
Calcium	62 3.10	42 2.10	21 1.05	-
Carbonate: CO_3	0 0.00	0 0.00	0 0.00	2 -
Chloride	234 6.60	50 1.41	37 1.04	25 0.70
Fluoride	-	-	-	-
Magnesium	99 8.18	14 1.18	16 1.31	-
Nitrate: NO_3	8.4 0.14	3.1 0.05	46 .74	0.0 0.00
Potassium	-	3.3 0.08	1.3 .03	-
Silica: SiO_2	-	-	-	-
Sodium	192 8.35	43 1.87	26 1.13	49 2.13
Sulfate: SO_4	-	62 1.29	-	-

1/ Sum

Table 82. MINERAL ANALYSES, BASINS 147 AND 148, PAJARO VALLEY AREA (Cont.)

Item	Ground Water				
	Wells				
Location Number	12S/02E-19M1	12S/02E-20K2	12S/02E-25M1	12S/02E-27F1	12S/02E-29L1
Date Sampled	9-26-68	7-21-70	3-5-70	3-4-70	7-27-70
Temperature (°F)	-	66	-	-	67
Specific Conductance (Micromhos @ 25° C)	1,310	607	736	351	570
pH	7.9	8.3	6.4	7.6	8.4
Percent Sodium	-	31	25	42	29
CONSTITUENTS in milligrams per liter (mg/l) / in milliequivalents per liter (meq)					
Total Dissolved Solids 1/	-	-	525	205	-
Hardness as $CaCO_3$					
Total	533	228	271	98	239
Noncarbonate	-	-	199	7	21
Bicarbonate: HCO_3	297 4.87	292 4.97	88 1.44	111 1.82	253 4.15
Boron	-	-	0.0 -	0.0 -	-
Calcium	-	42 2.10	65 3.24	18 .90	44 2.19
Carbonate: CO_3	0 -	0 0.00	0 0.00	0 0.00	6 .20
Chloride	237 6.68	43 1.21	50 1.41	44 1.24	31 .87
Fluoride	-	-	-	-	-
Magnesium	-	30 2.46	26 2.17	13 1.06	31 2.59
Nitrate: NO_3	0.0 0.0	5.0 .08	105 1.69	6.2 .10	4.8 .08
Potassium	-	2.6 .07	1.8 .05	1.8 .05	4.1 .11
Silica: SiO_2	-	-	-	-	-
Sodium	48 2.09	48 2.09	42 1.83	33 1.43	45 1.96
Sulfate: SO_4	-	-	123 2.56	6.9 .01	-

1/ Sum

Table 82. MINERAL ANALYSES, BASINS 147 and 148, PAJARO VALLEY AREA (Cont.)

Item	Ground Water			
	Wells			
Location Number	12S/01E-24N1	12S/02E-08G3	12S/02E-12E1	12S/02E-16J1
Date Sampled	7-27-70	7-27-70	7-27-70	7-27-70
Temperature (°F)	-	65	63	64
Specific Conductance (Micromhos @ 25° C)	1,080	520	1,150	770
pH	8.3	8.4	8.3	8.3
Percent Sodium	39	19	25	24
CONSTITUENTS in milligrams per liter (mg/l) / in milliequivalents per liter (meq)				
Total Dissolved Solids[1]	556	-	-	-
Hardness as $CaCO_3$				
Total	293	231	518	353
Noncarbonate	126	40	197	-
Bicarbonate: HCO_3	202 3.32	225 3.69	391 6.41	440 7.22
Boron	0.1 -	-	0.5 -	-
Calcium	41 2.05	54 2.69	53 2.64	69 3.44
Carbonate: CO_3	0 0.00	4 .13	0 0.00	0 0.00
Chloride	187 5.27	35 .99	83 2.44	43 1.21
Fluoride	-	-	-	-
Magnesium	46 3.80	23 1.93	94 7.71	44 3.62
Nitrate: NO_3	2.0 .03	4.7 .08	9.3 .15	2.6 .04
Potassium	17 .43	2.0 .05	1.9 .05	0.5 .01
Silica: SiO_2	-	-	-	-
Sodium	93 4.05	24 1.04	78 3.39	50 2.18
Sulfate: SO_4	93 1.94	-	-	-

1/ Sum

Table 82. MINERAL ANALYSES, BASINS 147 AND 148, PAJARO VALLEY AREA (Cont.)

Item	Ground Water			
	Wells			
Location	12S/02E-31K1	12S/02E-32K1	13S/01E-01A1	13S/02E-07R1
Date Sampled	8-26-68	9-27-67	7-3-68	7-28-70
Temperature (°F)	69	-	-	66
Specific Conductance (Micromhos @ 25° C)	1,950	592	3,760	1,060
pH	7.7	8.5	7.6	8.3
Percent Sodium	-	40	-	-
CONSTITUENTS in milligrams per liter (mg/l) / in milliequivalents per liter (meq)				
Total Dissolved Solids[1/]	-	-	-	-
Hardness as $CaCO_3$				
Total	680	163	1,230	122
Noncarbonate	-	50	-	-
Bicarbonate: HCO_3	201 3.30	130 3.13	265 4.35	254 4.16
Boron	-	0.1 -	-	0.3 -
Calcium	-	29 1.45	-	32 1.60
Carbonate: CO_3	0 0.00	4 0.13	0 0.00	0 0.00
Chloride	441 12.44	74 2.09	955 26.93	166 4.68
Fluoride	-	-	11 0.18	-
Magnesium	-	22 1.81	-	10 .84
Nitrate: NO_3	18 0.29	-	-	1.1 .02
Potassium	-	-	-	-
Silica: SiO_2	-	-	-	-
Sodium	107 4.65	51 2.22	260 11.31	180 7.84
Sulfate: SO_4	-	-	-	-

1/ Sum

MONTEREY COUNTY

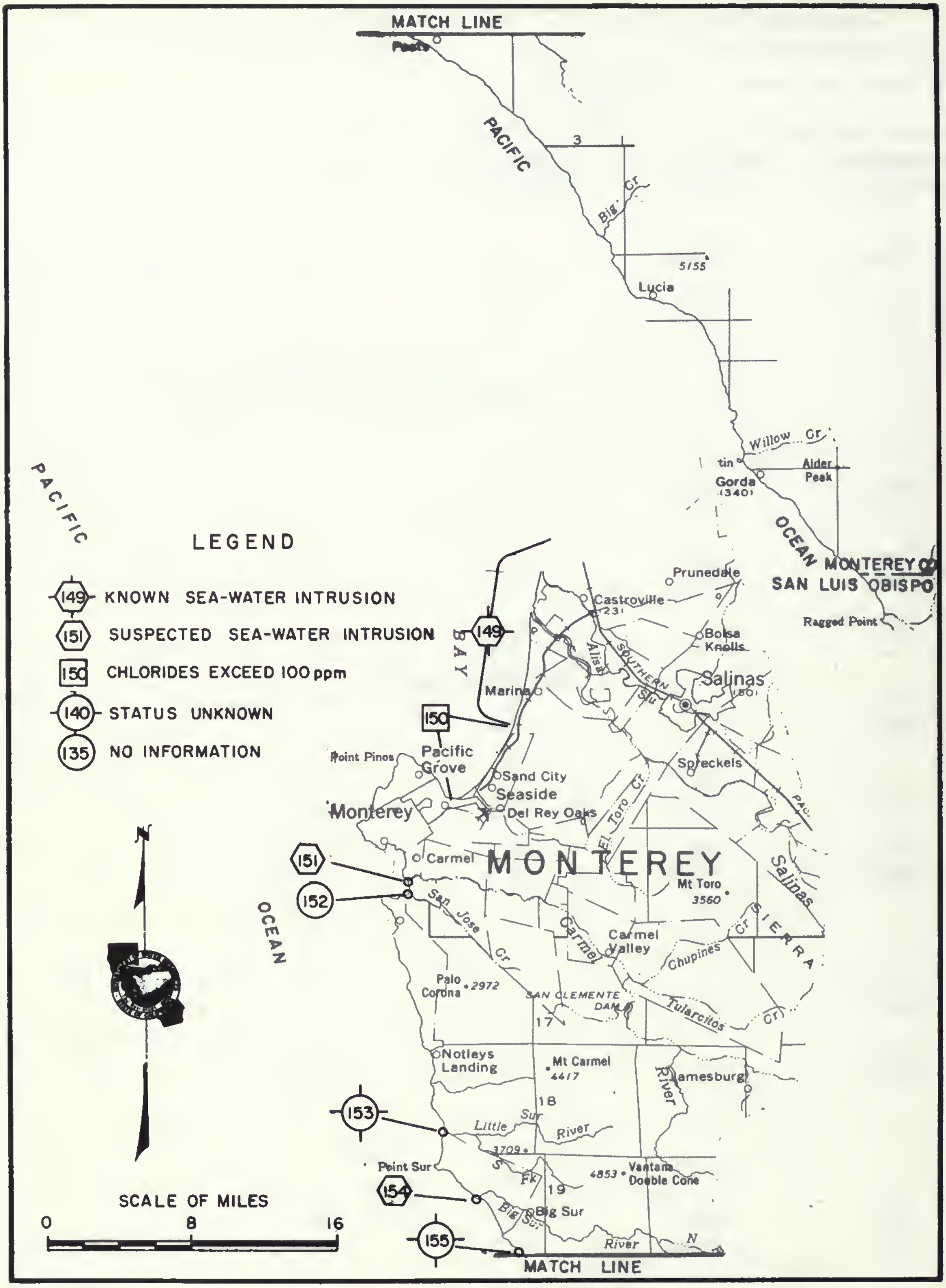


Figure 21. STATUS OF SEA-WATER INTRUSION, MONTEREY COUNTY 1970-1971

The seven identified ground water basins in coastal Monterey County lie in valley-fill alluvium and older water-bearing materials. They cover about 128 square miles and are open to the Pacific Ocean along 19 miles of coastline.

The largest basins are Basin 149, Salinas Valley, about 90 square miles; Basin 150, Monterey area, 25 square miles; and Basin 151, Carmel Valley, 11 square miles. The remaining valleys each cover less than 2 square miles.

Ground water in Basin 149, Salinas Valley, a coastal pressure area, occurs in a section of water-bearing materials that are as much as 1,000 feet thick near Salinas. Two major aquifers in the basin have been identified: the "180-foot" aquifer that lies in Quaternary sediments and the "400-foot" aquifer, which is part of the Aromas red sands of Pleistocene age and possibly part of the Paso Robles formation of Plio-Pleistocene age.

Ground water storage capacity in the upper 20 to 200 feet of water-bearing materials in Basin 149 is estimated to be about 3,070,000 acre-feet. Some 1,312,000 acre-feet of that amount is identified as usable ground water. No other estimates of ground water storage capacity are available for the area.

The potential for fresh water stored in offshore aquifers is unknown, except offshore from Salinas Valley and the Fort Ord-Monterey area. Recent studies by the U. S. Geological Survey in Monterey Bay have defined possible outcrop areas of the "180-foot" and "400-foot" aquifers on the floor of the bay and in the side walls of the Monterey submarine canyon. These studies indicate the existence offshore of a body of water-bearing materials that cover about 40 square miles and range in thickness from 60 to about 300 feet. This represents a large potential storage capacity for ground water for which, at this stage of investigation, no estimate has been made. Offshore water-bearing materials probably have been intruded by sea water, thus reducing the total volume of fresh water in storage. From the City of Monterey south to the Monterey-San Luis Obispo Counties boundary, offshore storage capacity is probably negligible or nonexistent.

Limited quantities of ground water for domestic use may be obtainable along the coast south of Monterey in the consolidated Mesozoic granitic and metamorphic rocks, in the Franciscan Group rocks, and in isolated shallow marine terrace deposits. These areas were not evaluated in this statewide sea-water intrusion inventory.

Table 83. STATUS OF SEA-WATER INTRUSION, MONTEREY COUNTY

Basin		1953-1955	1970-1971
No.	Name		
149	Salinas Valley Pressure Area	Known sea-water intrusion	Area increasing
150	Monterey Area	Chlorides exceed 100 ppm	Area increasing
151	Carmel Valley	No apparent sea-water intrusion	Suspected sea-water intrusion
152	San Jose Creek	No apparent sea-water intrusion	No information
153	Little Sur River	Status unknown	Status unknown
154	Big Sur River	No apparent sea-water intrusion	Suspected sea-water intrusion
155	Sycamore Canyon	Status unknown	Status unknown

BIBLIOGRAPHY

Monterey County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, San Luis Obispo Sheet. 1959.

2. Geologic Map of California, Santa Cruz Sheet. 1959.

California Department of Water Resources

3. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23, 31-33; Plate 10.

4. Status of Sea-Water Intrusion. December 1960. Pp. 126-133. (Unpublished; drafted as Appendix A of Bulletin No. 63).

5. Bulletin No. 66, Quality of Ground Waters in California, 1957. April 1960. Plate 4.

6. Bulletin No. 66-58, Quality of Ground Waters in California, 1958. November 1960. Plate 4.

7. Bulletin No. 66-59, Quality of Ground Waters in California, 1959; Part 1, Northern and Central California. July 1961. P. 116.

8. Bulletin No. 66-60, Quality of Ground Waters in California, 1960; Part 1, Northern and Central California. March 1964. Plate 10.

9. Bulletin No. 66-62, Quality of Ground Waters in California, 1961 and 1962; Part 1, Northern and Central California. August 1964. Plate 10.

10. Bulletin No. 130 Series, Hydrologic Data; Volume III, Appendixes C, D, and E. 1963 through 1971.

11. Bulletin No. 160-70, Water for California, the California Water Plan: Outlook in 1970. December 1970. 179 pages.

12. Influence of Industrial Waste Discharges upon Ground Waters in Lower Valley of Salinas River, Monterey County. Water Quality Function, Code 52-3-1C. October 1951. Mimeographed report.

13. Special Investigation--Salinas River Basin. Memorandum Report to the Central Coastal Regional Water Quality Control Board. January 1969.

14. Carmel River Basin Water Quality Investigation. Memorandum Report to the Central Coastal Regional Water Quality Control Board. October 1969.

15. Sea-Water Intrusion, Lower Salinas Valley. Progress Report, 1968-69. June 1970. 28 pages.

16. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

17. Special Investigation--Monterey County Coastal Drainage Basins. Memorandum Report to the Central Coastal Regional Water Quality Control Board. October 1971.

18. Sea-Water Intrusion, Lower Salinas Valley, Monterey County. District Report. San Joaquin District. July 1973. 91 pages.

California State Water Resources Control Board

19. Bulletin No. 19, Salinas River Basin Investigation. March 1955.

U. S. Geological Survey

20. Ground Water Data as of 1967, Central Coastal Subregion, California. Open File Report. March 5, 1969. Pp. 6-7.

21. Geology of Southern Monterey Bay and Its Relationship to the Ground Water Basin and Salt Water Intrusion. Open File Report. 1970.

Miscellaneous

22. Dill, R. F., R. S. Dietz, and H. Stewart. Deep-Sea Channel of the Monterey Canyon. Bulletin of the Geological Society of American. Vol. 65, No. 2. 1954.

23. Monterey County Flood Control and Water Conservation District. Basic Data and Operation Report--Hydrology, Ground Water and Climatology. Annual Report for Water Years 1958 through 1969.

Monterey County

SALINAS VALLEY PRESSURE AREA - BASIN 149

Location	Lying toward the coast from the City of Salinas, between Elkhorn Slough and Fort Ord.
Bibliography	Items 2, 3, 5, 6, 7, 8, 9, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23. Pages 182-183.
Description	A large alluvium-filled valley flanked by older elevated water-bearing materials. Area: about 90 square miles. Coastline: 12 miles.
Water Use	Development is predominately agricultural, with some urban and industrial areas. Ground water is the principal source of water supply for all uses in the area. Crops include lettuce, artichokes, sugar beets, alfalfa, and grain. Castroville, Salinas, Marina, and Fort Ord are the major population centers.
Water-bearing Sediments	Unconsolidated Quaternary alluvium and semi-consolidated Tertiary-Quaternary deposits are the chief water-bearing materials. Dune sands cover the older materials near Fort Ord. The principal aquifers in the coastal area are the "180-foot" and "400-foot" aquifers, which are separated intermittently by impermeable clay layers that retard direct recharge by rainfall or surface runoff. Recharge occurs primarily from the Forebay Area and locally through breaks in the clay layers and from subsurface inflow from the forebay area south of Salinas. In addition to the two aquifers, the basin also contains a shallow body of perched water. Inland from the coastal pressure area, at depths from 20 to 200 feet, the ground water storage capacity may be about 3,070,000 acre-feet. About 1,312,000 acre-feet may be usable capacity.
Ground Water Barriers	Ground water movement is impeded to the north by a buried clay-filled gorge near Elkhorn Slough and to the south by the Gabilan fault. No apparent barrier exists toward Monterey Bay.
Offshore Geology	The "180-foot" and "400-foot" aquifers outcrop on the floor of Monterey Bay and in the side walls of Monterey submarine canyon.
Sea-water Intrusion	Withdrawals of ground water for irrigation and for domestic and industrial use have caused a ground water depression that allows sea water to intrude into both the "180-foot" and "400-foot" aquifers. The result of this intrusion in the "180-foot" aquifer has been chloride concentrations of 100 ppm that extend inland for 4 miles and concentrations of 500 ppm that extend about 3.5 miles inland. The saline water enters the aquifer where it outcrops on the floor of Monterey Bay

about 3 miles offshore. Chloride concentration in areas of intrusion has increased steadily, causing wells to be abandoned. Inland penetration into the "180-foot" aquifer has progressed at an average annual rate of about 0.1 mile since 1950. An area of the same aquifer just west of Salinas contains chlorides in excess of 100 ppm, a condition probably attributable to an accumulation of salts that result from agricultural and industrial activity and domestic waste discharges, rather than to sea-water intrusion.

Sea water has also intruded a small area of the "400-foot" aquifer a distance of about 2 miles inland. This intrusion probably occurs through an outcrop of the aquifer about 5 miles offshore in Monterey Bay. Interchange between the two aquifers through breaks in separating aquicludes and through wells first drilled into the upper aquifer and then deepened into the lower one probably increases the rate and extent of intrusion.

Table 84. MINERAL ANALYSES, BASIN 149, SALINAS VALLEY PRESSURE AREA

Item	Surface Water	
	Tembladero Slough	Salinas River
Location Number	13S/02E-30J	14S/02E-33A
Date Sampled	7-25-70	8-25-70
Temperature (°F)	67	74
Specific Conductance (Micromhos @ 25° C)	2,430	1,380
pH	8.2	7.9
Percent Sodium	-	-
CONSTITUENTS $\frac{\text{in milligrams per liter (mg/l)}}{\text{in milliequivalents per liter (meq)}}$		
Total Dissolved Solids[a/]	-	-
Hardness as $CaCO_3$		
Total	498	424
Noncarbonate	-	-
Bicarbonate: HCO_3	410 6.72	354 5.80
Boron	-	-
Calcium	94 4.69	80 3.99
Carbonate: CO_3	0 0.00	0 0.00
Chloride	472 13.32	176 4.96
Fluoride	-	-
Magnesium	64 5.25	- 4.47
Nitrate: NO_3	0.0 0.00	11.5 0.19
Potassium	-	-
Silica: SiO_2	-	-
Sodium	352 15.31	145 6.31
Sulfate: SO_4	-	-

a/ Sum

Table 84. MINERAL ANALYSES, BASIN 149, SALINAS VALLEY PRESSURE AREA (Contd.)

Item	Ground Water Wells			
Location Number	13S/02E-16D1	13S/02E-17H3	13S/02E-23L1	13S/02E-29N1
Date Sampled	7-28-70	7-28-70	3-5-70	3-4-70
Temperature (°F)	66	66	-	-
Specific Conductance (Micromhos @ 25° C)	1,240	1,620	466	451
pH	8.2	8.1	7.2	7.9
Percent Sodium	-	-	57	59
CONSTITUENTS in milligrams per liter (mg/l) / in milliequivalents per liter (meq)				
Total Dissolved Solids[a]	-	-	302	288
Hardness as $CaCO_3$				
Total	331	325	86	87
Noncarbonate	154	168	37	0
Bicarbonate:	217 3.56	190 3.12	60 .99	141 2.31
Boron	0.2 -	0.2 -	0.0 -	0.0 -
Calcium	64 3.19	67 3.34	16 0.80	17 0.85
Carbonate: CO_3	0 0.00	0 0.00	0 0.00	0 0.00
Chloride	270 7.62	411 11.60	102 2.88	64 1.87
Fluoride	-	-	-	-
Magnesium	42 3.45	38 3.15	11 0.92	10 0.87
Nitrate: NO_3	13 .21	32 .52	67 .11	32 .52
Potassium	-	-	1.7 .04	2.1 .05
Silica: SiO_2	-	-	-	-
Sodium	118 5.14	197 8.56	53 2.31	58 2.52
Sulfate:	-	-	34 .71	3.6 .07

a/ Sum

Table 84. MINERAL ANALYSES, BASIN 149, SALINAS VALLEY PRESSURE AREA (Contd.)

Item	Ground Water Wells			
Location Number	13S/02E-31K1	13S/02E-33R1	14S/02E-05R2	14S/02E-13P1
Date Sampled	7/29-70	7-12-68	6-18-59	8-12-69
Temperature (°F)	-	-	66	67
Specific Conductance (Micromhos @ 25° C)	606	1,010	2,210	1,180
pH	8.0	8.2	7.6	7.9
Percent Sodium	-	-	21	-
CONSTITUENTS in milligrams per liter (mg/l) / in milliequivalents per liter (meq)				
Total Dissolved Solids[a]	-	-	1,220	815[b]
Hardness as $CaCO_3$				
Total	169	368	850	414
Noncarbonate	-	-	734	184
Bicarbonate: HCO_3	238 3.90	254 4.17	142 3.33	280 4.59
Boron	0.1 -	-	0.20 -	0.1 -
Calcium	43 2.14	-	2.14 10.68	86 4.29
Carbonate: CO_3	0 0.00	0 0.00	0 0.00	0 0.00
Chloride	70 1.97	131 3.69	608 17.15	158 4.46
Fluoride	-	-	0.3 0.02	-
Magnesium	15 1.24	-	77 6.33	48 3.95
Nitrate: NO_3	2.3 0.4	27 0.43	0.5 0.01	10 0.16
Potassium	-	-	6.1 0.16	4.3 0.11
Silica: SiO_2	-	-	41 -	-
Sodium	62 2.70	67 2.91	105 4.57	80 3.48
Sulfate: SO_4	-	-	102 2.12	141 2.93

a/ Sum
b/ Determined

Table 84. MINERAL ANALYSES, BASIN 149, SALINAS VALLEY PRESSURE AREA (Cont.)

Item	Ground Water Wells			
Location Number	14S/02E-14N1	14S/02E-18D1	14S/02E-24E1	14S/03E-30E1
Date Sampled	7-18-68	7-9-68	7-18-68	7-22-68
Temperature (°F)	-	63	71	-
Specific Conductance (Micromhos @ 25° C)	601	1,500	700	2,190
pH	8.2	8.0	8.1	8.0
Percent Sodium	-	-	-	-
CONSTITUENTS in milligrams per liter (mg/l) / in milliequivalents per liter (meq)				
Total Dissolved Solids[a/]	-	-	-	-
Hardness as $CaCO_3$				
Total	183	534	218	732
Noncarbonate	-	-	-	-
Bicarbonate: HCO_3	199 3.26	2.44 4.00	210 3.44	411 6.74
Boron	-	-	-	-
Calcium	-	-	-	-
Carbonate: CO_3	0 0.00	0 0.00	0 0.00	0 0.00
Chloride	62 1.75	274 7.73	80 2.26	372 10.49
Fluoride	-	-	-	-
Magnesium	-	-	-	-
Nitrate: NO_3	3.7 0.06	5.5 0.09	3.5 0.06	13 0.21
Potassium	-	-	-	-
Silica: SiO_2	-	-	-	-
Sodium	54 2.35	124 5.39	59 2.56	184 8.00
Sulfate: SO_4	-	-	-	-

a/ Sum

Monterey County

MONTEREY AREA - BASIN 150

Location	Between Fort Ord and Monterey, 10 miles southwest of Salinas.
Bibliography	Items 2, 4, 13, 15, 16, 17, 21, 23. Pages 182-183.
Description	An area composed of sand dunes, alluvium, and older sediments. Area: about 25 square miles. Coastline: 6 miles.
Water Use	Ground water is used to supply the domestic needs of the communities of Seaside, Monterey, and Del Monte. Small areas are irrigated with ground water in the Marina area. There is no appreciable use of surface water. Streamflow is intermittent and of short duration, making up local storm drainage.
Water-bearing Sediments	Ground water occurs in unconsolidated Quaternary alluvium, sand dunes, and underlying and slightly compacted gravel and sand of the Paso Robles formation. Deep wells near Fort Ord and Seaside supply most water demand in the area. Surface water supplies developed by local water companies provide municipal water to the Monterey peninsula.
Ground Water Barriers	The Tularcitos fault may form a barrier to ground water movement within the basin.
Sea-water Intrusion	Several local areas of high mineral concentrations found in the Monterey area near the coast during the summer of 1953 probably represent the natural quality of available ground water. Near Seaside, chloride concentrations ranging from 69 to 204 ppm are found in an area of about 4 square miles, extending 3 miles inland. The condition represents available native ground water.

Table 85. MINERAL ANALYSES, BASIN 150, MONTEREY AREA

Item	Ground Water Wells		
Location Number	14S/01E-24K1	14S/01E-24Q2	14S/01E-25L1
Date Sampled	10-9-70	8-14-68	10-9-70
Temperature (°F)	-	65	-
Specific Conductance (Micromhos @ 25° C)	743	1,480	472
pH	7.7	7.8	7.7
Percent Sodium	-	-	-
CONSTITUENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)			
Total Dissolved Solids[a]	-	-	-
Hardness as $CaCO_3$			
Total	199	418	96
Noncarbonate	120	392	63
Bicarbonate: HCO_3	97 1.59	32 0.52	40 0.66
Boron	-	-	-
Calcium	49 2.45	-	17 0.85
Carbonate: CO_3	0 0.00	0 0.00	0 0.00
Chloride	122 3.44	224 6.32	105 2.96
Fluoride	-	-	-
Magnesium	19 1.54	-	13 1.07
Nitrate: NO_3	77 1.24	0.7 0.01	21 0.34
Potassium	-	-	-
Silica: SiO_2	-	-	-
Sodium	67 2.91	122 5.31	51 2.22
Sulfate	-	-	-

a/ Sum

Table 85. MINERAL ANALYSES, BASIN 150, MONTEREY AREA (Cont.)

Items	Ground Water Wells		
Location Number	15S/01E-22C1	14S/01E-25P1	14S/01E-25P2
Date Sampled	8-14-68	10-9-70	10-9-70
Temperature (°F)	-	-	-
Specific Conductance (Micromhos @ 25° C)	910	602	550
pH	7.3	7.5	7.5
Percent Sodium	-	-	-
CONSTITUENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)			
Total Dissolved Solids[a]	-	-	-
Hardness as $CaCO_3$			
Total	236	147	126
Noncarbonate	-	93	102
Bicarbonate: HCO_3	203 3.33	66 1.08	30 0.48
Boron	-	-	-
Calcium	-	33 1.65	22 1.10
Carbonate: CO_3	0 0.00	0 0.00	0 0.00
Chloride	128 3.61	96 2.71	102 2.88
Fluoride	-	-	-
Magnesium	-	16 1.29	17 1.42
Nitrate: NO_3	12 0.19	74 1.19	54 0.87
Potassium	-	-	-
Silica: SiO_2	-	-	-
Sodium	87 3.78	57 2.48	52 2.26
Sulfate: SO_4	-	-	-

a/ Sum

Table 85. MINERAL ANALYSES, BASIN 150, MONTEREY AREA (Cont.)

Item	Ground Water Wells	
Location Number	15S/01E-23G1	15S/01E-26N2
Date Sampled	8-29-67	8-14-68
Temperature (°F)	-	75
Specific Conductance (Micromhos @ 25° C)	475	1,080
pH	-	7.3
Percent Sodium	-	-
CONSTITUENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)		
Total Dissolved Solids[a]	-	-
Hardness as $CaCO_3$		
Total	-	220
Noncarbonate	-	-
Bicarbonate: HCO_3	-	142 2.33
Boron	-	-
Calcium	-	-
Carbonate: CO_3	-	0 0.00
Chloride	85 2.40	204 5.75
Fluoride	-	-
Magnesium	-	-
Nitrate: NO_3	-	8.5 0.14
Potassium	-	-
Silica: SiO_2	-	-
Sodium	-	122 5.31
Sulfate: SO_4	-	-

a/ Sum

Monterey County

CARMEL VALLEY - BASIN 151

Location	4 miles south of Monterey.
Bibliography	Items 2, 3, 4, 14, 16, 17, 23. Pages 182-183.
Description	An alluvium-filled valley that also contains terrace deposits. Area: 11 square miles. Coastline: 500 feet.
Water Use	Surface water is stored in upland reservoirs for delivery to urban areas for domestic use. Ground water is used to meet the need for most irrigation and a limited amount of domestic use.
Water-bearing Sediments	Quaternary alluvium composed of sand and gravel, between 100 and 150 feet thick, lies beneath the valley floor. Ground water supplements domestic surface water supplies during the summer when surface water has significantly diminished.
Ground Water Barriers	None known.
Offshore Geology	The Carmel submarine canyon may have cut into the offshore extension of the water-bearing materials.
Sea-water Intrusion	Sea-water intrusion is suspected since chlorides in one well exceeded 100 mg/l. There is no evidence that a landward ground water gradient occurred.

Table 86. MINERAL ANALYSES, BASIN 151, CARMEL VALLEY

Item	Surface Water Carmel River	
Location Number	16S/01W-13Q	
Date Sampled	4-23-69	7-2-69
Temperature (°F)	-	-
Specific Conductance (Micromhos @ 25° C)	355	576
pH	7.8	8.0
Percent Sodium	18	23
CONSTITUTENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)		
Total Dissolved Solids[a]	210	356
Hardness as $CaCO_3$		
Total	131	223
Noncarbonate	38	102
Bicarbonate: HCO_3	114 1.87	148 2.43
Boron	0.03 -	0.0 -
Calcium	35 2.62	57 2.84
Carbonate: CO_3	0 0.00	0 0.00
Chloride	19 0.54	42 1.18
Fluoride	-	-
Magnesium	11 0.89	20 1.64
Nitrate: NO_3	0.3 0.00	0.3 0.00
Potassium	2.1 0.05	3.9 0.10
Silica: SiO_2	-	-
Sodium	18 0.78	32 1.39
Sulfate: SO_4	47 0.98	116 2.42

a/ Sum

Table 86. MINERAL ANALYSES, BASIN 151, CARMEL VALLEY (Cont.)

Item	Ground Water Wells				
Location Number		16S/01W-13L2		16S/01W-13R1	16S/01E-16N1
Date Sampled	10-16-58	9-13-65	4-23-69	8-28-64	8-7-63
Temperature (°F)	63	60	-	-	-
Specific Conductance (Micromhos @ 25° C)	785	925	888	793	812
pH	8.1	7.6	8.0	8.5	8.0
Percent Sodium	29	37	-	29	24
CONSTITUENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)					
Total Dissolved Solids a/	554 b/	644	539	453 b/	516 b/
Hardness as $CaCO_3$					
Total	290	351	300	273	319
Noncarbonate	86	138	98	99	108
Bicarbonate: HCO_3	237 3.89	260 4.26	246 4.03	171 2.80	257 4.21
Boron	0.18 -	0.1 -	0.0 -	0.1 -	0.1 -
Calcium	73 3.64	97 4.84	79 3.94	70 3.49	89 4.44
Carbonate: CO_3	0 0.00	0 0.00	0 0.00	20 0.67	0 0.00
Chloride	86 2.43	159 4.48	106 2.99	67 1.89	51 1.44
Fluoride	0.4 0.02	-	-	-	-
Magnesium	23 1.89	26 2.17	25 2.05	24 1.96	23 1.93
Nitrate: NO_3	1 0.02	2.1 0.03	1.3 0.02	1.8 0.03	0.9 0.01
Potassium	3.5 0.09	4.6 0.12	3.3 0.08	3.9 0.10	2.6 0.07
Silica: SiO_2	17 -	-	-	-	-
Sodium	54 2.35	96 4.18	66 2.87	53 2.30	48 2.09
Sulfate: SO_4	81 1.68	112 2.33	90 1.87	114 2.34	128 2.66

a/ Sum

b/ Determined

Monterey County

SAN JOSE CREEK BASIN - BASIN 152

Location	On the south side of Carmel Bay, 6 miles south of Monterey.
Bibliography	Items 2, 4, 14, 16, 17, 23. Pages 182-183.
Description	An alluvium-filled valley extending east from the coast. Area: 0.1 square mile. Coastline: 1,800 feet.
Water Use	Ground water is used for irrigation and domestic needs.
Water-bearing Sediments	Unconsolidated Quaternary alluvium whose thickness and physical characteristics are unknown.
Ground Water Barriers	None known.
Offshore Geology	The Carmel submarine canyon may have cut into the offshore extension of water-bearing materials.
Sea-water Intrusion	There was no evidence of intrusion in 1953. In 1953, the concen- of total dissolved solids in ground water was 254 ppm and concentration of chlorides was 82 ppm, providing a mineral quality suitable for most existing beneficial uses. No information available in 1970-71. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 87. MINERAL ANALYSES, BASIN 152,
SAN JOSE CREEK BASIN

Item	Surface Water San Jose Creek	Ground Water Well
Location Number	16S/01W-23R	16S/01W-24N1
Date Sampled	5-5-70	1-21-53
Temperature	59	-
Specific Conductance (Micromhos @ 25° C)	270	485
pH	7.6	6.8
Percent Sodium	-	33
CONSTITUENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)		
Total Dissolved Solids[a]	-	254
Hardness as $CaCO_3$		
Total	89	142
Noncarbonate	20	92
Bicarbonate: HCO_3	84 1.38	60 0.98
Boron	-	0.01 -
Calcium	20 1.00	37 1.85
Carbonate: CO_3	0 0.00	0 0.00
Chloride	31 0.87	82 2.31
Fluoride	-	0.8 0.04
Magnesium	9.5 0.78	12 0.99
Nitrate: NO_3	0.8 0.18	3.2 0.05
Potassium	-	5.0 0.13
Silica: SiO_2	-	6 -
Sodium	23 1.00	33 1.44
Sulfate: SO_4	-	46 0.96

a/ Sum

LITTLE SUR RIVER BASIN - BASIN 153

Location	About 18 miles south of Monterey.
Bibliography	Items 2, 3, 4, 16. Pages 182-183.
Description	An alluvium-filled valley. Area: 0.3 square mile. Coastline: 2,100 feet.
Water Use	The entire valley is undeveloped, except for some stock grazing at a small ranch situated a half mile inland. Surface water is used for stockwatering. No development of ground water has been observed.
Water-bearing Sediments	Unconsolidated Quaternary alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	Movement along Sur Hill Thrust and Sur Thrust, which extend across the coastal segment of the valley, probably antedates alluviation in the valley. No information is available to determine whether these faults may form a barrier to ground water movement in the unconsolidated alluvium.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 88. MINERAL ANALYSES, BASIN 153, LITTLE SUR RIVER BASIN

Item	Surface Water	
	Little Sur River	
Location Number	18S/10E-29Q	
Date Sampled	4-22-69	1-21-70
Temperature	56	60
Specific Conductance (Micromhos @ 25° C)	239	199
pH	7.6	7.7
Percent Sodium	16	15
CONSTITUENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)		
Total Dissolved Solids[a]	142	-
Hardness as $CaCO_3$		
Total	105	84
Noncarbonate	7	1
Bicarbonate: HCO_3	120 1.97	101 1.66
Boron	-	-
Calcium	30 1.50	17 .85
Carbonate: CO_3	0.0 -	0.0 -
Chloride	8.4 .24	7.1 2.0
Fluoride	-	-
Magnesium	7.3 .60	10 .83
Nitrate: NO_3	0.0 -	0.2 -
Potassium	0.7 .02	-
Silica: SiO_2	-	-
Sodium	9.0 .39	6.8 .30
Sulfate: SO_4	15 .31	-

a/ Sum

BIG SUR RIVER BASIN - BASIN 154

Location	22 miles south of Monterey.
Bibliography	Items 2, 3, 4, 16. Pages 182-183.
Description	Alluvium-filled valley extending southeast from the coast. Area: 1.75 square mile. Coastline: 750 feet.
Water Use	Three wells adjacent to the mouth of the channel of Big Sur River provide domestic, irrigation, and some stock water. Surface water is used for remaining stockwatering, for recreation, and for maintaining natural fisheries and wildlife habitats.
Water-bearing Sediments	Unconsolidated Quaternary alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	Midsummer irrigation and heavy domestic demands at Point Sur Navy Station cause salt-water intrusion to extend 1,500 feet inland at the mouth of Big Sur River. The intrusion is repulsed annually by winter recharge. There was no evidence of sea-water intrusion or degraded water in the coastal segment of this valley in summer, 1955. Sea-water intrusion is suspected since chlorides in one well exceeded 100 mg/l. There is no evidence that a landward ground water gradient occurred.

Table 89. MINERAL ANALYSES, BASIN 154, BIG SUR RIVER BASIN

Item	Surface Water	Ground Water					
	Big Sur River	Wells					
Location Number Date Sampled	19S/02E-29N 1-21-70	19S/01E-08C1 3-4-71	19S/01E-09M1 9-3-70	19S/01E-16E1 7-30-70	19S/01E-16F1 9-3-70	19S/01E-16F2 7-30-70	 9-3-70
Temperature (°F)	58	-	-	-	-	-	-
Specific Conductance (Micromhos @ 25° C)	187	743	462	8,580	1,830	364	374
pH	7.8	7.8	8.1	7.5	8.2	7.8	8.3
Percent Sodium	-	-	-	-	-	-	-
CONSTITUENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)							
Total Dissolved Solids[a]	-	3.13[b]	259[b]	-	1,060	-	186[b]
Hardness as $CaCO_3$							
Total	81	169	168	1,750	348	154	137
Noncarbonate	0	-	-	-	-	-	-
Bicarbonate: HCO_3	93 1.52	154 2.53	179 2.94	138 2.26	154 2.53	158 2.59	156 2.56
Boron	- -	0.0 -	0.0 -	-	0.0 -	-	0.0 -
Calcium	23 -	34 1.70	34 1.70	21 1.05	82 4.09	38 1.90	41 2.05
Carbonate: CO_3	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00
Chloride	3.1 0.09	74 2.09	34 1.04	2,900 81.78	465 13.11	25 0.70	14 0.39
Fluoride	-	-	-	-	-	-	-
Magnesium	-	20 1.64	20 1.64	-	35 2.88	-	85 6.99
Nitrate: NO_3	0.2 0.00	13 0.21	0.6 0.01	0.6 0.01	0.0 0.00	0.3 0.01	0.0 0.00
Potassium	-	0.6 0.02	0.5 0.01	-	4.8 0.12	-	1.4 0.04
Silica: SiO_2	-	-	-	-	-	-	-
Sodium	4.8 0.21	54 2.35	34 1.48	1,170 50.90	235 10.22	21 0.91	16 0.70
Sulfate: SO_4	-	36 0.75	36 0.75	-	81 1.68	-	20 0.42

a/ Sum
b/ Determined

Monterey County

SYCAMORE CANYON BASIN - BASIN 155

Location	About 26 miles south of Monterey.
Bibliography	Items 2, 3, 4, 16. Pages 182-183.
Description	An alluvium-filled valley extending east from the coast. Area: 0.2 square mile. Coastline: about 600 feet.
Water Use	The entire valley is used for stock grazing. Surface water is used for stockwatering. No observed development of ground water.
Water-bearing Sediments	Unconsolidated Quaternary alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 90. MINERAL ANALYSES, BASIN 155, SYCAMORE CANYON BASIN

Item	Surface Water Sycamore Creek
Location Number	19S/01E-35H
Date Sampled	7-28-53
Temperature (°F)	66
Specific Conductance (Micromhos @ 25° C)	342
pH	7.7
Percent Sodium	-
CONSTITUENTS, in milligrams per liter (mg/l) / in milliequivalents per liter (meq)	
Total Dissolved Solids	-
Hardness as $CaCO_3$	
Total	109
Noncarbonate	16
Bicarbonate: HCO_3	114 1.87
Boron	.07 -
Calcium	24 1.20
Carbonate: CO_3	0.0 -
Chloride	38 1.07
Fluoride	0.2 -
Magnesium	12 .99
Nitrate: NO_3	0.1 -
Potassium	0.6 .02
Silica: SiO_2	13 -
Sodium	27 1.17
Sulfate: SO_4	20 .42

SAN LUIS OBISPO COUNTY

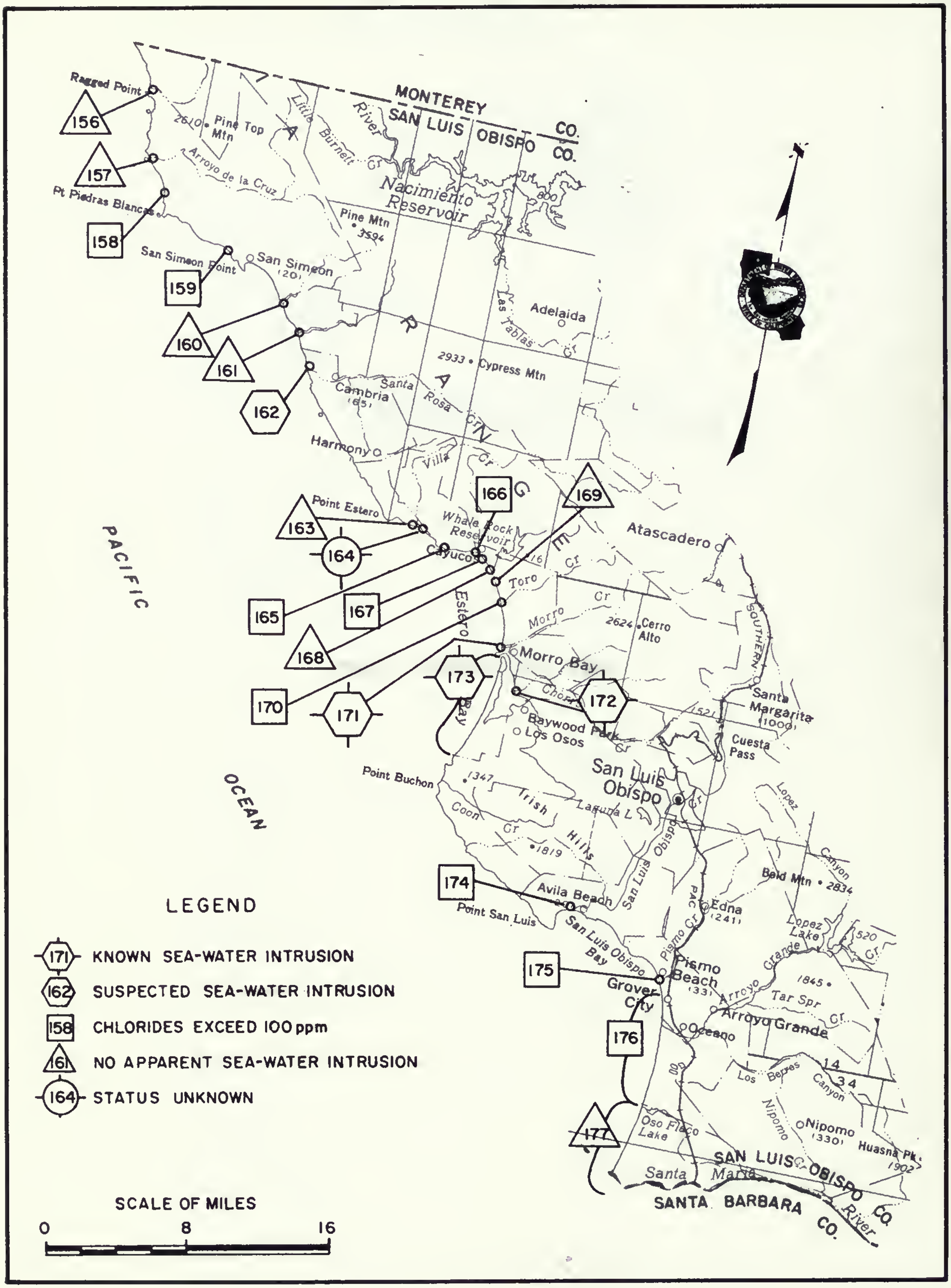


Figure 22. STATUS OF SEA-WATER INTRUSION, SAN LUIS OBISPO COUNTY 1970-1971

SAN LUIS OBISPO COUNTY

The 22 identified ground water basins in coastal San Luis Obispo County lie in unconsolidated alluvium and in older saturated sediments, including the Paso Robles formation of Plio-Pleistocene age and the Careaga sand of Pliocene age. They cover about 163 square miles and are open to the Pacific Ocean along about 27 miles of coastline.

The five largest basins, which lie in the southern part of the county, range from 8 to 100 square miles. Their combined total storage capacity is an estimated 3,205,200 acre-feet and their combined usable capacity is an estimated 1,069,700 acre-feet. The remaining 17 basins each cover less than 3 square miles. Ten of these smaller basins, which lie in the northern and central parts of the county, can store an estimated 72,400 acre-feet of ground water, of which an estimated 20,600 acre-feet is usable.

Offshore aquifers offer sizeable potential storage for fresh water along the county's southern coastline. The base of fresh water in the two major ground water basins extends for great depths below sea level. In Basin 177, the base is about 1,200 feet deep; in Basin 176, the base is about 700 feet deep; and in Basin 173, the base may be about 390 feet deep. Geologic studies suggest that these water-bearing sediments extend beneath the continental shelf for an indeterminate distance.

Limited quantities of water for domestic use may be obtainable from older consolidated Franciscan formation rocks and Cretaceous sedimentary rocks in the northern part of the county and from Miocene sedimentary rocks in the southern part where weathering, jointing, and fracturing have created some secondary porosity and permeability. These areas were excluded from this inventory.

Table 91. STATUS OF SEA-WATER INTRUSION, SAN LUIS OBISPO COUNTY

Basin No.	Basin Name	1953-55	1970-71
156	San Carpoforo	Status unknown	No apparent sea-water intrusion
157	Arroyo de la Cruz	No apparent sea-water intrusion	No change
158	Arroyo del Corral	Chlorides exceed 100 ppm	No change
159	Arroyo Laguna	Status unknown	Chlorides exceed 100 ppm in 1966
160	Pico Creek	No apparent sea-water intrusion	No change
161	San Simeon	No apparent sea-water intrusion	No change
162	Santa Rosa Creek	No apparent sea-water intrusion	Suspected sea-water intrusion
163	Villa	Chlorides exceed 100 ppm	No change
164	Geronimo	Status unknown	Status unknown
165	Cayucos Point	Chlorides exceed 100 ppm	No change
166	Cayucos	Chlorides exceed 100 ppm	No change
167	Little Cayucos	Chlorides exceed 100 ppm	No change
168	Old Creek	No apparent sea-water intrusion	No change
169	Willow Creek	Status unknown	No evidence of sea-water intrusion
170	Toro	Chlorides exceed 100 ppm	No change
171	Morro	Chlorides exceed 100 ppm	Known sea-water intrusion
172	Chorro	Chlorides exceed 100 ppm	Known sea-water intrusion
173	Los Osos	No apparent sea-water intrusion	Known sea-water intrusion
174	San Luis Obispo	No apparent sea-water intrusion	Chlorides exceed 100 ppm
175	Pismo	Chlorides exceed 100 ppm	No change
176	Arroyo Grande	No apparent sea-water intrusion	Chlorides exceed 100 ppm
177	Santa Maria River Valley	No apparent sea-water intrusion	No change

BIBLIOGRAPHY

San Luis Obispo County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, San Luis Obispo Sheet. 1959.

2. Geologic Map of California, Santa Maria Sheet. 1959.

California Department of Water Resources

3. Bulletin No. 18, San Luis Obispo County Investigation; Appendix B, Geology and Ground Water of San Luis Obispo County. May 1958. Pp. 41-55.

4. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23.

5. Status of Sea-Water Intrusion. December 1960. Pp. 133-152. (Unpublished; drafted as Appendix A of Bulletin No. 63).

6. Bulletin No. 63-3, Sea-Water Intrusion, Pismo-Guadalupe Area. February 1970. 82 pages.

7. Bulletin No. 63-6, Sea-Water Intrusion: Morro Bay Area, San Luis Obispo County. February 1972.

8. Bulletin No. 103, San Luis Obispo and Santa Barbara Counties Land and Water Use Survey. June 1964. 72 pages.

9. Bulletin No. 130 Series, Hydrologic Data; Volume V, Appendixes C, D, E. 1963 through 1971.

10. Bulletin No. 160-70, Water for California, The California Water Plan: Outlook in 1970. December 1970. 179 pages.

11. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

U. S. Geological Survey

12. Geology and Ground Water Resources of the Santa Maria Valley Area, California. Water Supply Paper 1000. 1951. 169 pages.

13. Utilization of Ground Water in the Santa Maria Valley Area, California. Water Supply Paper 1819-A. 1966. 24 pages.

14. Ground-Water Data as of 1967. Central Coastal Subregion, California. Open File Report. March 5, 1969. Pp. 8-11.

Miscellaneous

15. Max Bookman and Robert Edmonston (Consulting Engineers), Water Requirements of Santa Barbara County, 1967 to 1990. Consulting Engineers Report. February 1968. Pp. 12-13, 16, 18-20, 25-28, 30-32.

SAN CARPOFORO BASIN - BASIN 156

Location	3 miles south of Monterey-San Luis Obispo county line.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending southeast from the coast. Area: 0.3 square miles. Coastline: 500 feet.
Water Use	Essentially undeveloped, except for some stock-watering and domestic use.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to 60 feet. Permeability and porosity: moderate to high. Estimated saturated ground water storage capacity: 1,800 acre-feet; usable capacity: 600 acre-feet. Underlain and surrounded by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion. Hydraulic gradient is probably moving seaward.

Table 92. MINERAL ANALYSES, BASIN 156,
SAN CARPOFORO

Item	Ground Water
	Tony Williams Ranch
Base and Meridian	Mount Diablo
Location Number	25S/6E-16A2
Date Sampled	11-11-67
Character	CaMgHCO3
Temperature (°F)	59
Specific Conductance (micromhos at 25° C)	412
pH	8.1
Percent sodium	11
CONSTITUENTS, in parts per million	
Total Dissolved Solids	217
Total Hardness as $CaCO_3$	205
Bicarbonate: HCO_3	224
Boron	0.08
Calcium	36
Chloride	17
Fluoride	0.18
Magnesium	28
Nitrate: NO_3	0
Potassium	0.8
Sodium	12
Sulfate: SO_4	25

San Luis Obispo County

ARROYO DE LA CRUZ BASIN - BASIN 157

Location	4 miles south of San Carpoforo Basin, 2.5 miles north of Piedras Blancas Point.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending southeast from coast. Area: 1.2 square miles. Coastline: 1,500 feet.
Water Use	Moderate development for stock-watering, irrigation, and domestic use.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to 130 feet. Permeability and porosity: moderate to high. Ground water: largely unconfined, with water level elevations above sea level. Estimated saturated ground water storage capacity: 6,600 acre-feet; usable capacity: 2,200 acre-feet. Underlain and surrounded by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion. The hydraulic gradient is seaward.

Table 93. MINERAL ANALYSIS, BASIN 157, ARROYO DE LA CRUZ

Item	Stock Well
Base and Meridian	Mount Diablo
Location Number	25S/6E-33N1
Date Sampled	10-6-70
Temperature (°F)	60
Field EC	385
pH	8.3
Chloride (ppm)	14

ARROYO DEL CORRAL BASIN - BASIN 158

Location	1 mile north of Piedras Blancas Point.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-veneered stream-cut canyon extending east from the coast. Area: 0.1 square mile. Coastline: 1,000 feet.
Water Use	One windmill supplies water for cattle.
Water-bearing Sediments	Recent alluvium surrounded on north and south by terraces. Thickness and physical characteristics unknown; well logs lacking.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water with chlorides exceeding 100 ppm occurred in the coastal portion of the valley in the summer of 1955 and the fall of 1970. This water may be derived from underlying formations.

Table 94. MINERAL ANALYSIS, BASIN 158, ARROYO DEL CORRAL

Item	Domestic and Stock Well
Base and Meridian	Mount Diablo
Location Number	26S/6E-11H1
Date Sampled	10-6-70
Temperature (°F)	59
Field EC	1,050
pH	7.8
Chloride (ppm)	180

ARROYO LAGUNA BASIN - BASIN 159

Location	1.5 miles northwest of San Simeon Point.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending northeast from the coast. Area: 0.1 square mile. Coastline: 1,800 feet.
Water Use	Nonirrigated hay and grain used for stock grazing.
Water-bearing Sediments	Recent alluvium. Thickness and physical characteristics unknown; well logs lacking.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	In 1966 chlorides exceeded 100 ppm. Historical data lacking; high chlorides may be derived from underlying formations. Hydrologic data lacking; hydraulic gradient is probably moving seaward.

Table 95. MINERAL ANALYSIS, BASIN 159, ARROYO LAGUNA

Item	Ground Water
	San Luis Obispo County Beaches and Parks
Base and Meridian	Mount Diablo
Location Number	26S/7E-26C1
Date Sampled	9-26-66
Character	$CaMgNaHCO_3$
Temperature (°F)	64
Specific Conductance (micromhos at 25° C)	969
pH	8.3
CONSTITUENTS, in parts per million	
Total Dissolved Solids	598
Hardness as $CaCO_3$	
Total	400
Noncarbonate	88
Bicarbonate: HCO_3	380
Boron	0.1
Calcium	78
Carbonate: CO_3	0
Chloride	112
Magnesium	50
Nitrate: NO_3	0.7
Potassium	2.0
Sodium	44
Sulfate: SO_3	29

San Luis Obispo County

PICO CREEK BASIN - BASIN 160

Location	3 miles southeast of San Simeon Point.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending northeast from coast. Area: 0.1 square mile. Coastline: 1,750 feet.
Water Use	Ninety percent of the basin is native vegetation and nonirrigated hay; the remainder is developed in irrigated pasture.
Water-bearing Sediments	Recent alluvium. Thickness and physical characteristics unknown; well logs lacking.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion. Hydrologic data lacking; hydraulic gradient is probably moving seaward.

Table 96. MINERAL ANALYSIS, BASIN 160, PICO CREEK

Item	W. H. Allen Domestic Well
Base and Meridian	Mount Diablo
Location Number	27S/8E-6G1
Date Sampled	10-6-70
Temperature (°F)	63
Field EC	600
pH	8.3
Chloride (ppm)	32

SAN SIMEON BASIN - BASIN 161

Location	3 miles northwest of Cambria.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending east from coast. Area: 0.9 square mile. Coastline: 1,600 feet.
Water Use	Moderate development for irrigation, domestic use, and stock-watering.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to 100 feet. Permeability and porosity: high. Ground water largely unconfined, with water level elevations above sea level. Estimated saturated ground water storage capacity: 4,000 acre-feet; usable capacity: 1,300 acre-feet. Underlain and surrounded by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion. Throughout the basin, hydraulic gradient is seaward.

Table 97. MINERAL ANALYSIS, BASIN 161, SAN SIMEON

Item	Ground Water Mary Bonomi Irrigation Well
Base and Meridian	Mount Diablo
Location Number	27S/8E-9P2
Date Sampled	12-10-69
Character	$CaMgHCO_3$
Temperature (°F)	60
Specific Conductance (micromhos at 25° C)	626
pH	7.7
CONSTITUENTS, in parts per million	
Total Dissolved Solids	314
Total Hardness as $CaCO_3$	293
Bicarbonate: HCO_3	292
Boron	0.17
Calcium	55
Carbonate: CO_3	0
Chloride	22
Fluoride	6.26
Magnesium	38
Nitrate: NO_3	4
Potassium	0.8
Sodium	16
Sulfate: SO_4	46

San Luis Obispo County

SANTA ROSA CREEK BASIN - BASIN 162

Location	Near Cambria.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley that includes Harmony and Green Valleys. Area: 2.3 square miles. Coastline: 1,800 feet.
Water Use	Irrigated pasture and grain crops and urban development. Numerous wells for irrigation, stock watering, and domestic use.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to more than 130 feet. Permeability and porosity: high. Ground water is unconfined. Estimated saturated ground water storage capacity: 24,700 acre-feet; usable capacity: 6,000 acre-feet. Underlain and surrounded by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water, with chlorides approaching 1,000 ppm occurs in the coastal segment of this valley. This value was based on sampling performed in December 1969. Evidence points toward possible intrusion of sea water. A seaward hydraulic gradient may exist over most of the basin. Chlorides have increased more than ten times since 1955, at which time they had reached 80 ppm.

Table 98. MINERAL ANALYSIS, BASIN 162, SANTA ROSA CREEK

Item	Ground Water
	San Luis Obispo County Domestic and Park Well
Base and Meridian	Mount Diablo
Location Number	27S/8E-21R3
Date Sampled	12-10-69
Character	$MgCaHCO_3$
Temperature (°F)	54
Specific Conductance (micromhos at 25° C)	3,618
pH	7.7
CONSTITUENTS, in parts per million	
Total Dissolved Solids	2,637
Hardness as $CaCO_3$	
Total	1,573
Noncarbonate	1,147
Percent Sodium	11
Bicarbonate: HCO_3	519
Boron	0.23
Calcium	224
Carbonate: CO_3	0
Chloride	933
Fluoride	0.45
Magnesium	247
Nitrate: NO_3	1
Potassium	13
Sodium	169
Sulfate: SO_4	170

San Luis Obispo County

VILLA BASIN - BASIN 163

Location	4 miles west of Cayucos.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending north from coast. Area: 1.5 square miles. Coastline: 850 feet.
Water Use	Irrigated pasture and grain growing.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to 130 feet. Permeability and porosity: high. Ground water is unconfined. Estimated saturated ground water storage capacity: 6,600 acre-feet; usable capacity: 2,200 acre-feet. Underlain and surrounded by Jurassic and Cretaceous rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal part of this valley in the summer of 1955 and during the period 1967-1969.

Current sampling in June 1974 by San Luis Obispo County Flood Control and Water Conservation District indicates chlorides in excess of 800 ppm. It is not known whether this area of degraded ground water is due to sea-water intrusion or some other cause.

Table 99. MINERAL ANALYSIS, BASIN 163, VILLA

Item	Stock Well
Base and Meridian	Mount Diablo
Location and Number	28S/9E-26N3
Date Sampled	6-19-74
Temperature (°F)	-
Field EC	-
pH	-
Chloride (ppm)	824

San Luis Obispo County

GERONIMO BASIN - BASIN 164

Location	2.5 miles southeast from China Harbor.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending north from coast. Area: 0.1 square mile. Coastline: 750 feet.
Water Use	Undeveloped. No observed use of surface or ground water.
Water-bearing Sediments	Recent alluvium surrounded by Terrace deposits. Thickness and physical characteristics unknown; well logs lacking.
Ground Water Barriers	None known.
Offshore Geology	Alluvium most probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No information available. Fresh water inflow may be sufficient to maintain ground water levels at or above sea level with a seaward hydraulic gradient.

San Luis Obispo County

CAYUCOS POINT BASIN - BASIN 165

Location	2.5 miles northwest of Cayucos.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending north from the coast. Area: 0.4 square mile. Coastline: 500 feet.
Water Use	Nonirrigated hay, grain, and some stock grazing.
Water-bearing Sediments	Recent alluvium with Terrace deposits on east and west sides of basin. Thickness and physical characteristics unknown; well logs lacking.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal part of the valley during the summer of 1955 and fall of 1970. Ground water is probably moving along a seaward gradient. Degraded water may be derived from underlying formations.

Table 100. MINERAL ANALYSIS, BASIN 165, CAYUCOS POINT

Item	Stock Well
Base and Meridian	Mount Diablo
Location Number	28S/10E-31F1
Date Sampled	10-13-70
Temperature (°F)	72
Field EC	1,500
pH	8.5
Chloride (ppm)	280

San Luis Obispo County

CAYUCOS BASIN - BASIN 166

Location	0.5 mile northwest of Cayucos.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending north from the coast. Area: 0.9 square mile. Coastline: 750 feet.
Water Use	Irrigated and nonirrigated pasture and grain. Few small residences.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to 120 feet. Permeability and porosity: high. Ground water is unconfined. Estimated saturated ground water storage capacity: 4,000 acre-feet; usable capacity: 1,300 acre-feet. Surrounded and underlain by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water with chlorides exceeding 100 ppm. Historically, as indicated by sampling done in the summer of 1955, chlorides have exceeded this value.

Table 101. MINERAL ANALYSIS, BASIN 166, CAYUCOS

Item	Stock Well
Base and Meridian	Mount Diablo
Location Number	28S/10E-32A3
Date Sampled	10-14-70
Temperature (°F)	63
Field EC	1,350
pH	8.4
Chloride (ppm)	120

San Luis Obispo County

LITTLE CAYUCOS BASIN - BASIN 167

Location	0.25 mile northwest of Cayucos.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending northeast from the coast. Area: 0.2 square mile. Coastline: 500 feet.
Water Use	Principally urban. Domestic water supply from Cayucos and Old Creek Basin.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Permeability and porosity: high. Surrounded and underlain by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water with chlorides exceeding 100 ppm. Historically, as indicated by sampling done in the summer of 1955, chlorides have exceeded this value. Degraded water may be derived from underlying formations. Ground water probably moving along a seaward hydraulic gradient.

Table 102. MINERAL ANALYSIS, BASIN 167, LITTLE CAYUCOS

Item	Domestic Well
Base and Meridian	Mount Diablo
Location Number	28S/10E-33L1
Date Sampled	10-14-70
Temperature (°F)	63
Field EC	1,150
pH	8.0
Chloride (ppm)	145

OLD CREEK BASIN - BASIN 168

Location	0.25 mile southeast of Cayucos.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending northeast from the coast. Area: 1.2 square miles. Coastline: 500 feet.
Water Use	Irrigated field crops, largely alfalfa. Some irrigation wells and several domestic and stock watering wells supply local needs. Some water pumped to Cayucos.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to 135 feet. Permeability and porosity: high. Ground water is unconfined. Estimated saturated ground water storage capacity: 4,600 acre-feet; usable capacity: 1,500 acre-feet. Surrounded and underlain by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion. A seaward hydraulic gradient exists.

Table 103. MINERAL ANALYSIS, BASIN 168, OLD CREEK

Item	Paso Robles Beach Mutual Water Co. Municipal Well
Base and Meridian	Mount Diablo
Location Number	29S/10E-3C4
Date Sampled	10-15-70
Temperature (°F)	63
Field EC	850
pH	7.9
Chloride (ppm)	55

San Luis Obispo County

WILLOW CREEK BASIN - BASIN 169

Location	1.5 miles southeast of Cayucos.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending northeast from the coast. Area: 0.4 square mile. Coastline: 375 feet.
Water Use	Principally urban, with several farms and residences inland. Some nonirrigated pasture in upper portion of the basin. Very little development of surface or ground water.
Water-bearing Sediments	Recent alluvium. Thickness and physical characteristics unknown; well logs lacking.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion. Ground water is probably moving in a seaward hydraulic gradient.

Table 104. MINERAL ANALYSIS, BASIN 169, WILLOW CREEK

Item	Mario Negranti Irrigation and Domestic Well
Base and Meridian	Mount Diablo
Location Number	29S/10E-2C1
Date Sampled	10-15-70
Temperature (°F)	66
Field EC	600
pH	8.0
Chloride (ppm)	80

San Luis Obispo County

TORO BASIN - BASIN 170

Location	1.5 miles north of Morro Bay.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	An alluvium-filled valley extending northeast from the coast. Area: 0.8 square mile. Coastline: 1,200 feet.
Water Use	Predominantly agricultural, with irrigated grain and pasture. Moderately developed surface and ground water.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to 80 feet. Permeability and porosity: high. Ground water largely unconfined. Estimated saturated ground water storage capacity: 2,900 acre-feet; usable capacity: 1,000 acre-feet. Surrounded and underlain by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water, with chlorides exceeding 100 ppm. Historically, as indicated by sampling done in the summer of 1955, chlorides have exceeded this value. Degraded ground water may be derived from underlying formations. Ground water is probably moving in a seaward hydraulic gradient.

Table 105. MINERAL ANALYSIS, BASIN 170, TORO

Item	Peter Negranti, Jr. Irrigation Well
Base and Meridian	Mount Diablo
Location Number	29S/10E-11H1
Date Sampled	10-16-70
Temperature (°F)	62
Field EC	1,000
pH	8.0
Chloride (ppm)	120

San Luis Obispo County

MORRO BASIN - BASIN 171

Location	1 mile north of Morro Bay.
Bibliography	Items 1, 3, 5, 7. Page 209.
Description	An alluvium-filled valley extending northeast from the coast. Area: 2.0 square miles. Coastline: 1,000 feet.
Water Use	Truck crops on valley floor; urban development on terraces. Ground water derived mostly from valley fill. Some ground water obtained from Terrace deposits for industrial use.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium, terrace deposits and dune sands. Thickness: 60 feet at mouth of Morro Creek. Permeability and porosity: moderate to high. Ground water largely unconfined. Estimated saturated ground water storage capacity: 7,600 acre-feet; usable capacity: 2,000 acre-feet. Unconsolidated Terrace deposits, ranging from 0 to 60 feet thick, flank the alluvium-filled valley. Water-bearing materials surrounded and underlain by Franciscan group rocks.
Ground Water Barriers	None known.
Offshore Geology	Alluvium and Terrace materials probably continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal part of the valley in the summer of 1955. Sea-water degradation of several wells in alluvial materials was detected in mid-1960. Sea-water intrusion into Upper Pleistocene sand dunes just north of the mouth of Morro Creek was detected in one well in 1959. Sampling of two coastal area wells in September 1970 indicated chlorides of about 690 ppm and 900 ppm. Current sampling in September 1973 indicates that the well with 690 ppm chlorides had increased to about 1800 ppm. During periods of heavy pumping, water levels near the coast fall below sea level. If these levels remain low for any extended period, sea-water intrusion can occur.

Table 106. MINERAL ANALYSIS, BASIN 171, MORRO

Item	Ground Water				
	City of Morro Bay No. 1		City of Morro Bay No. 2	City of Morro Bay No. 3	
Base and Meridian	Mount Diablo		Mount Diablo	Mount Diablo	
Location Number	29S/10E-25E1		29S/10E-25E2	29S/10E-25C2	
Date Sampled	9-70	9-73	9-70	3-20-70	9-70
Character	-	-	-	$MgCaHCO_3$	-
Temperature (°F)	-	-	-	62	-
Specific Conductance (micromhos at 25°C)	-	-	-	1,208	-
pH	-	-	-	7.5	-
CONSTITUENTS, in parts per million					
Total Dissolved Solids	-	-	-	682	-
Hardness as $CaCO_3$					
Total	-	-	-	578	-
Noncarbonate	-	-	-	156	-
Percent Sodium	-	-	-	11	-
Bicarbonate: HCO_3	-	-	-	515	-
Boron	-	-	-	0.10	-
Calcium	-	-	-	81	-
Carbonate: CO_3	-	-	-	0	-
Chloride	692	1,800	900	105	230
Fluoride	-	-	-	0.38	-
Magnesium	-	-	-	91	-
Nitrate: NO_3	-	-	-	11	-
Potassium	-	-	-	1	-
Sodium	-	-	-	50	-
Sulfate: SO_4	-	-	-	89	-

San Luis Obispo County

CHORRO BASIN - BASIN 172

Location	Near Morro Bay.
Bibliography	Items 1, 3, 5, 7. Page 209.
Description	An alluvium-filled valley extending southeast from Morro Bay. Area: 2.8 square miles. Coastline: 1,500 feet.
Water Use	Irrigated crops and dry-farmed grain.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 70 feet near the mouth of Chorro Creek. Ground water essentially unconfined. Estimated saturated ground water storage capacity: 9,600 acre-feet; usable capacity: 2,500 acre-feet. Surrounded and underlain by Franciscan group rocks and Miocene intrusives.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore beneath Morro Bay and may be in hydraulic continuity with bay water.
Sea-water Intrusion	An area of degraded water occurred in the coastal part of the valley in the summer of 1955. During the 1959-60 dry period, chloride concentrations in this area attained levels of 2,000 to 2,500 ppm. The 1970 area of chlorides exceeding 100 ppm probably underlies most of the bay-side portion of the valley. During periods of heavy pumping, wells near the coast have become saline and then slowly recovered. Water levels near the coast fluctuate from just above to below sea level, threattening immediate or potential sea-water intrusion. Faulty well casings near the coast may allow tidal water to move down into producing aquifers. Throughout the basin, a seaward hydraulic gradient exists.

Table 107. MINERAL ANALYSES, BASIN 172, CHORRO

Item	Ground Water: San Luis Obispo County Municipal Well
Base and Meridian	Mount Diablo
Location Number	29S/11E-32M1
Date Sampled	3-20-70
Character	$MgHCO_3$
Temperature (°F)	63
Specific Conductance (micromhos at 25° C)	1,609
pH	7.7
CONSTITUENTS, in parts per million	
Total Dissolved Solids	920
Hardness as $CaCO_3$	
Total	727
Noncarbonate	188
Percent sodium	21
Bicarbonate: HCO_3	657
Boron	0.08
Calcium	66
Carbonate: CO_3	0
Chloride	185
Fluoride	0.32
Magnesium	137
Nitrate: NO_3	27
Potassium	3.5
Sodium	87
Sulfate: SO_4	86

LOS OSOS BASIN - BASIN 173

Location	3 miles south of Morro Bay.
Bibliography	Items 1, 3, 5, 7. Page 209.
Description	Alluvium-filled valley covered by coastal dune sands extending east from coast. Area: 12.4 square miles. Coastline: 3.5 miles.
Water Use	Large urban development, with some irrigated crops and dry-farmed grain. Many irrigation and domestic wells.
Water-bearing Sediments	A thick section of moderately to highly permeable water-bearing materials extends to about 390 feet below ground at Morro Bay. Ground water is unconfined. Unconsolidated alluvium is a maximum 70 feet thick; Paso Robles formation is about 290 feet thick near Morro Bay. Older dune sands are a maximum of about 150 feet thick. Estimated saturated ground water storage capacity: 95,000 acre-feet; usable capacity: 9,000 acre-feet. Surrounded and underlain by Franciscan group rocks and Miocene intrusives and consolidated sediments.
Ground Water Barriers	None known.
Offshore Geology	Alluvium, sand dunes, and Paso Robles formation continue offshore. All may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion in coastal part found during 1955 inventory. Since 1955, sampling has indicated two small areas of degraded ground water which probably represent sea-water intrusion. Sampling in 1957, 1967, and 1970 of two wells in the northern part found high chlorides in Recent alluvium. Sampling in 1966 in the southern part near the main sand bar located high chlorides in a well in the old sand dunes. Well No. 30S/11E-9P1 in the inland area east of Baywood Park is probably not degraded by sea water but represents native quality ground water. A seaward hydraulic gradient exists over the entire basin; however, valley-wide intrusion of sea water is threatened if population continues to grow and rely on ground water. Increased pumpage may lower water levels below sea level and reduce the existing seaward hydraulic gradient.

Table 108. MINERAL ANALYSIS, BASIN 173, LOS OSOS

Item	Turri Bros. Irrigation Well
Base and Meridian	Mount Diablo
Location Number	30S/11E-22L1
Date Sampled	10-20-70
Temperature (°F)	64
Field EC	1,260
pH	8.0
Chloride	220

SAN LUIS OBISPO BASIN - BASIN 174

Location	6 miles northwest of Pismo Beach.
Bibliography	Items 1, 3, 5, 11. Page 209.
Description	A small alluvium-filled valley extending north from the coast and merging with the larger inland San Luis Valley. Area, small valley: 0.5 square mile. Coastline: 1,800 feet.
Water Use	Irrigated truck crops, hay, grain, and nonirrigated crops. Surface water is diverted for irrigation.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium. Thickness: 0 to 160 feet. Ground water is unconfined. Estimated saturated ground water storage capacity from 20-to 160-foot depths: 67,000 acre-feet; usable capacity: 22,000 acre-feet. Underlain by Franciscan group rocks and consolidated Miocene sediments.
Ground Water Barriers	None known.
Offshore Geology	Alluvium probably continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	In October 1970, chlorides exceeded 300 ppm. Historically, they have exceeded 800 ppm and dropped below 100 ppm. Source of degraded water is unknown. However, intrusion is threatened at the coastal portion of the valley where the valley is overlain by a tidal slough. A seaward hydraulic gradient exists throughout the basin.

Table 109. MINERAL ANALYSIS, BASIN 174, SAN LUIS OBISPO

Item	Oceano Mutual Water Co. Municipal Well
Base and Meridian	Mount Diablo
Location Number	31S/12E-32D2
Date Sampled	10-21-70
Temperature (°F)	64
Field EC	2,200
pH	8.0
Chloride (ppm)	380

San Luis Obispo County

PISMO BASIN - BASIN 175

Location	Near Pismo Beach.
Bibliography	Items 1, 6. Page 209.
Description	A small alluvium-filled valley extending northeast from the coast and merging with the larger inland San Luis Valley. Area, small valley: 0.5 square mile. Coastline: 2,500 feet.
Water Use	Irrigated truck crops, dry-farmed crops, and urban development.
Water-bearing Sediments	Recent and Upper Pleistocene alluvium and sand dunes. Thickness: 0 to 160 feet. Permeability and porosity: moderate to high. Ground water is unconfined to semiconfined. Estimated saturated ground water storage capacity in the depth range of 10- to 110-feet: 30,000 acre-feet; usable capacity: 10,000 acre-feet. Underlain by Lower Pleistocene Paso Robles formation of moderate permeability and Careaga sand of Pliocene age.
Ground Water Barriers	None known.
Offshore Geology	Alluvium and older water-bearing sediments continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water occurred in the summer of 1955. In 1967 several wells were found to be producing water containing increasing concentrations of chlorides that exceeded 500 ppm. Further investigations disclosed that these chlorides originated from the natural salinity of the geologic environment, from concentrated salt resulting from evapotranspiration, and from the percolation of sea water entering tidal channels during extremely high tides. A seaward hydraulic gradient exists throughout the basin. A natural sea water wedge may exist in two areas: in unconfined ground water of marine terrace deposits north of Pismo Creek where a slight seaward gain in chlorides occurs; and in a south-sloping salt-water wedge in the Careaga sand and the B-zone of the Paso Robles formation.

Table 110. MINERAL ANALYSIS, BASIN 175, PISMO

Item	Ground Water: S. M. Ferreira Irrigation Well
Base and Meridian	Mount Diablo
Location Number	32S/12E-13R1
Date Sampled	10-5-67
Character	NaCa $ClHCO_3$
Temperature (°F)	64
Specific Conductance (micromhos at 25° C)	5,634
pH	7.4
CONSTITUENTS, in parts per million	
Total Dissolved Solids	3,640
Total Hardness as $CaCO_3$	1,763
Bicarbonate: HCO_3	377
Boron	0.16
Calcium	369
Chloride	1,626
Fluoride	0.5
Magnesium	205
Nitrate: NO_3	4.5
Potassium	14
Sodium	455
Sulfate: SO_4	183

ARROYO GRANDE BASIN - BASIN 176

Location	Near Arroyo Grande and Oceano.
Bibliography	Items 1 and 6. Page 209.
Description	A small alluvium-filled valley. Area: about 12 square miles. Coastline: about 6 miles. The basin is flanked on the south by younger and older dune sands that merge into Basin 177. No firm boundary exists between Basins 176 and 177.
Water Use	Irrigated and nonirrigated crops and urban development. Many irrigation, domestic, and municipal wells.
Water-bearing Sediments	A thick section of water-bearing materials occurs in the coastal portion of the valley. The base of fresh water in the Paso Robles formation and Careaga sand is located about 700 feet below sea level. These materials and the unconsolidated alluvium are extensively distributed and are moderately to highly permeable. Ground water is unconfined to confined. Estimated ground water storage capacity at 100- to 800-foot depths: 996,000 acre-feet; usable capacity: 40,000 acre-feet. Underlain by Franciscan group rocks and Miocene consolidated sediments and intrusives.
Ground Water Barriers	None known.
Offshore Geology	Alluvium and older water-bearing sediments continue offshore and may be in hydraulic continuity with the ocean at a considerable distance offshore. These reservoir conditions favor an extensive and thick accumulation of offshore fresh water.
Sea-water Intrusion	No evidence of intrusion. For the most part, the hydraulic gradient is seaward. Sufficient fresh water flows into the coastal part of the valley to hold ground water levels at or above sea level and maintain a seaward hydraulic gradient. Increased pumping could create a threat of sea-water intrusion. Chlorides in shallow ground water bodies in the coastal part of the valley range from 100 to 200 ppm, and appear to be related to a surface source not sea water.

Table 111. MINERAL ANALYSIS, BASIN 176, ARROYO GRANDE

Item	Charles Price Domestic Well
Base and Meridian	Mount Diablo
Location Number	32S/13E-28E1
Date Sampled	10-22-70
Temperature (°F)	71
Field EC	1,050
pH	7.5
Chloride (ppm)	60
Character	$CaMgNaHCO_3$

San Luis Obispo County

SANTA MARIA RIVER VALLEY - BASIN 177

Location	130 miles northwest of Los Angeles and 60 miles northwest of Santa Barbara; lies partly in Santa Barbara County.
Bibliography	Items 1, 2, 6, 12, 13, 14, 15. Page 209.
Description	One of the larger coastal valleys in Southern California. Area: 100 square miles. East-west length: 28 miles. Maximum north-south width: 15 mile. Coastline: 7.5 miles.
Water Use	Irrigated truck crops; increasing high urban development. Over 1,000 irrigation, public supply, and industrial wells present.
Water-bearing Sediments	A thick section of water-bearing materials occurs in the coastal portion. The base of fresh water in the Paso Robles formation and Careaga sand is located about 900 to 1,200 feet below sea level. These materials and the unconsolidated alluvium are distributed widely and are moderately to highly permeable. Ground water unconfined in the eastern portion, confined in the western portion. Estimated ground water storage capacity at 20- to 200-foot depths: 2,000,000 acre-feet; usable capacity: 1,000,000 acre-feet. Usable ground water stored above sea level amounts to 1,800,000 acre-feet. Underlain by older consolidated Tertiary rocks.
Ground Water Barriers	None known in coastal portion. In eastern portion, a fault that offsets the Paso Robles formation about 150 feet may affect ground water movement.
Offshore Geology	Alluvium and older water-bearing sediments continue offshore and may be in hydraulic continuity with the ocean for a considerable distance offshore. These reservoir conditions favor an extensive and thick accumulation of offshore fresh water.
Sea-water Intrusion	No evidence of intrusion. A seaward hydraulic gradient exists. Wells in the coastal portion flow when water levels are high. Presently, sufficient fresh water flows into the coastal part of the valley to maintain safe ground water levels. Increased pumping may reverse the hydraulic gradient and encourage sea-water intrusion. Shallow ground water with chlorides ranging from 100 to 200 ppm appears to be moving toward the sea. These chloride waters do not originate from intruded sea water.

Table 112. MINERAL ANALYSIS, BASIN 177, SANTA MARIA RIVER VALLEY

Item	M. J. Ellis Domestic & Irrigation Well
Base and Meridian	San Bernardino
Location Number	10N/35W-7K1
Date Sampled	10-22-70
Temperature (°F)	61
Field EC	1,550
pH	8.0
Chloride (ppm)	90
Character	$CaMgSO_4$

SANTA BARBARA COUNTY

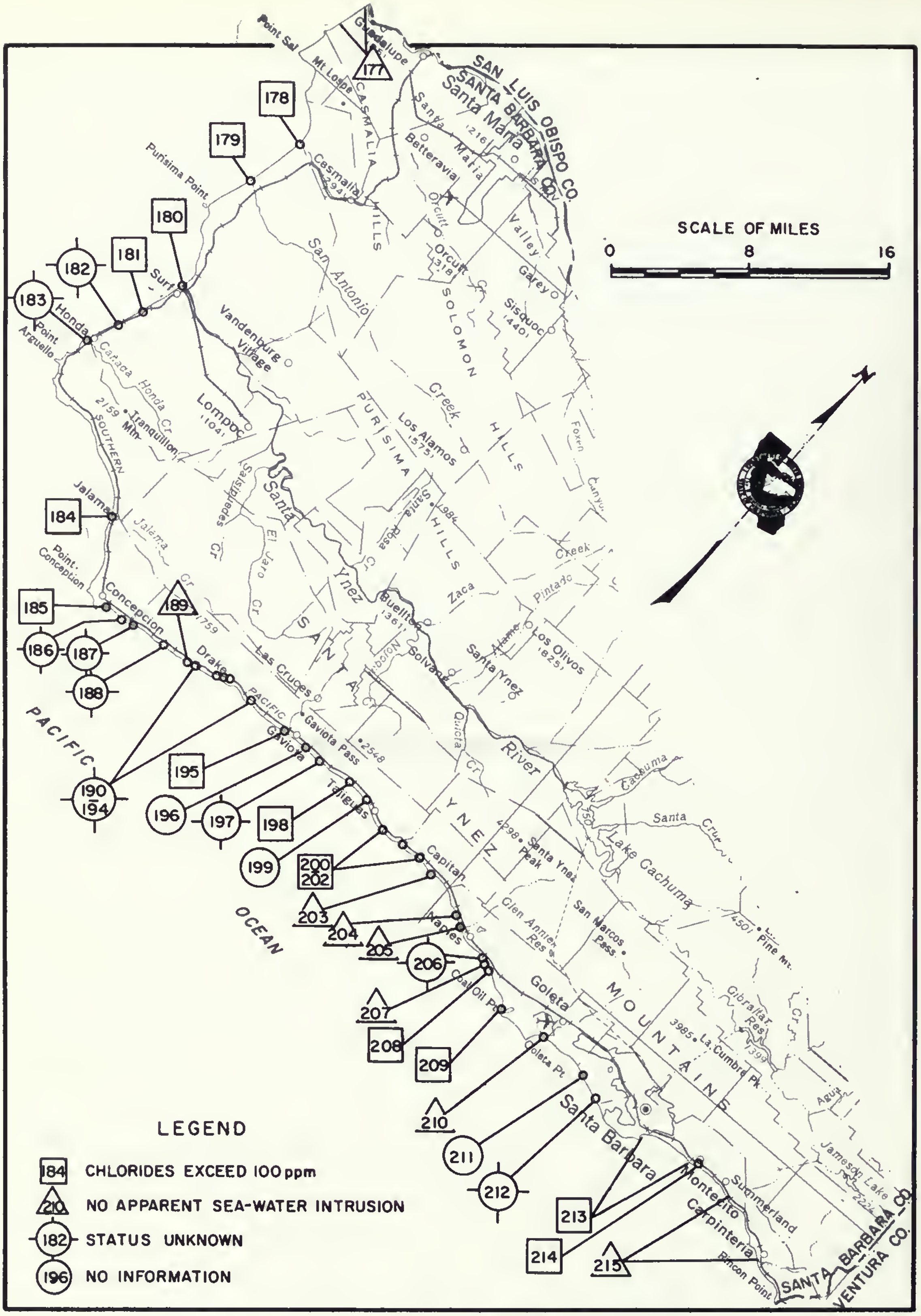


Figure 23. STATUS OF SEA-WATER INTRUSION, SANTA BARBARA COUNTY 1970-1971

The 38 identified ground water basins in coastal Santa Barbara County include alluvium-filled valleys and older water-bearing materials. They cover about 410 square miles and are open to the Pacific Ocean along about 19 miles. Thirty-two basins each cover less than one square mile. The rest range from 6 to 260 square miles.

In six basins, ground water occurs in unconsolidated alluvium and in older saturated sediments, including the Casitas formation and Orcutt Sand of Pleistocene age, the Paso Robles and Santa Barbara formations of Plio-Pleistocene age, and the Careaga sand of Pliocene age. More ground water may be available in the many shallow marine terraces that flank small alluvium-filled valleys west of Santa Barbara.

The six basins together store an estimated 5,585,000 acre-feet of ground water and three of these store an estimated 698,000 acre-feet of usable ground water.

Although the potential capacity of offshore aquifers to store fresh water is unknown, Basins 179 and 180 appear to offer the most probable locations. Geological evidence indicates that offshore outcroppings of consolidated rocks in portions of Basins 213, 214, and 215 in the eastern part of the county would restrict the amount of unconsolidated sediments there, drastically reducing their potential for offshore storage.

Limited quantities of water for domestic use may be obtainable from Middle and Late Tertiary sedimentary rocks along the entire coastline where weathering, jointing, and fracturing have created some secondary porosity and permeability. These areas were not covered in the statewide inventory.

Table 113. STATUS OF SEA-WATER INTRUSION, SANTA BARBARA COUNTY

Basin		1953-55	1970-71
No.	Name		
178	Schumann Canyon	Chlorides exceed 100 ppm	No change
179	San Antonio Creek Valley	Status unknown	Chlorides exceed 100 ppm
180	Santa Ynez River Valley	Chlorides exceed 100 ppm	No change
181	Lompoc Terrace	Status unknown	Chlorides exceed 100 ppm
182	Spring Canyon	Status unknown	Status unknown

Table 113. STATUS OF SEA-WATER INTRUSION, SANTA BARBARA COUNTY (Cont.)

Basin		1953-55	1970-71
No.	Name		
183	Canada Honda	Status unknown	Status unknown
184	Jalama	Status unknown	Chlorides exceed 100 ppm
185	Cojo	Chlorides exceed 100 ppm	No change
186	Damsite Canyon	Status unknown	Status unknown
187	Canada del Cojo	Status unknown	Status unknown
188	Gato	Status unknown	Status unknown
189	San Augustine	No apparent sea-water intrusion	No change
190	Agujas	Status unknown	Status unknown
191	Bulito	Status unknown	Status unknown
192	Canada de la Brea	Status unknown	Status unknown
193	Canada de Santa Anita	Status unknown	Status unknown
194	Alegria	Status unknown	Status unknown
195	Gaviota	Chlorides exceed 100 ppm	No change
196	Cementario	Chlorides exceed 100 ppm	No information
197	Canada San Onofre	Status unknown	Status unknown
198	Arroyo Hondo	No apparent sea-water intrusion	Chlorides exceed 100 ppm
199	Arroyo Quemada	No apparent sea-water intrusion	No information
200	Tajiguas	Chlorides exceed 100 ppm	No change
201	Canada del Refugio	Chlorides exceed 100 ppm	No change

Table 113. STATUS OF SEA-WATER INTRUSION, SANTA BARBARA COUNTY (Cont.)

Basin No.	Basin Name	1953-55	1970-71
202	Canada del Corral	Chlorides exceed 100 ppm	No change
203	Capitan	No apparent sea-water intrusion	No change
204	Las Varas	Chlorides exceed 100 ppm	Area of chlorides in excess of 100 ppm has disappeared
205	Dos Pueblos	No apparent sea-water intrusion	No change
206	Eagle Canyon	Status unknown	Status unknown
207	Tecolote	No apparent sea-water intrusion	No change
208	Bell Canyon	Chlorides exceed 100 ppm	No change
209	Campbell Creek	Chlorides exceed 100 ppm	No change
210	Goleta	No apparent sea-water intrusion	No change
211	Hope Valley	Chlorides exceed 100 ppm	No information
212	San Roque	Status unknown	Status unknown
213	Santa Barbara	No apparent sea-water intrusion	Chlorides exceed 100 ppm
214	Montecito Area	Status unknown	Chlorides exceeded 100 ppm in 1964
215	Carpinteria	No apparent sea-water intrusion	No change

BIBLIOGRAPHY

Santa Barbara County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, Santa Maria Sheet. 1959.

2. Bulletin No. 150, Geology of Southwestern Santa Barbara County, California, Point Arguello, Lompoc, Point Conception, Los Olivos and Gaviota Quadrangles. 1961. 95 pages.

3. Geologic Map of California, Los Angeles Sheet. 1969.

California Department of Water Resources

4. Bulletin No. 63, Sea-Water Intrusion in California. November 1958.

5. Status of Sea-Water Intrusion. December 1960. Pp. 153-181. (Unpublished; drafted as Appendix A of Bulletin No. 63).

6. Bulletin No. 103, San Luis Obispo and Santa Barbara Counties Land and Water Use Survey. June 1964. 72 pages.

7. Bulletin No. 130, Hydrologic Data; Volume V, Appendixes C, D, and E. 1963 through 1971.

8. Bulletin No. 160-70, Water for California, The California Water Plan: Outlook in 1970. December 1970. 179 pages.

9. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

U. S. Geological Survey

10. Water Supply Paper 1068, Wells and Water Levels in Principal Ground-Water Basins in Santa Barbara County, California. 1950. 459 pages.

11. Water Supply Paper 1107, Geology and Water Resources of the Santa Ynez River Basin, Santa Barbara County, California. 1951. 194 pages.

12. Water Supply Paper 1108, Geology and Ground-Water Resources of the South-Coast Basins of Santa Barbara County, California, with a Section on Surface Water Resources. 1959. 119 pages.

13. Water Supply Paper 1467, Ground-Water Appraisal of Santa Ynez River Basin, Santa Barbara County, California, 1945-1952. 1959. 119 pages.

14. Water Supply Paper 1619-F, Geology and Ground-Water Features of Point Arguello Naval Missile Facility, Santa Barbara County, California. 1963. 35 pages.

15. Water Supply Paper 1664, Geology and Ground Water of San Antonio Creek Valley, Santa Barbara County, California. 1964. 53 pages.

16. Water Supply Paper 1809-S, Suitability of Irrigation Water and Changes in Ground Water Quality in the Lompoc Subarea of the Santa Ynez River Basin, Santa Barbara County, California. 1965. 20 pages.

17. Water Supply Paper 1859-A, Ground-Water Reconnaissance of the Santa Barbara-Montecito Area, Santa Barbara County, California. 1968. 28 pages.

18. Open-File Report, Yield of the Carpinteria and Goleta Ground-Water Basins, Santa Barbara County, California, 1941-58. 1962. 112 pages.

19. Open-File Report, Hydrologic Inventory of the Lompoc Subarea, Santa Ynez River Basin, Santa Barbara County, California, 1957-1962, with a Section on Perennial Supply. 1966. 27 pages.

20. Open-File Report, Ground-Water Data as of 1967. Central Coastal Subregion California. March 5, 1969. Pp. 10-13.

21. Open-File Report, Ground Water in Santa Barbara and Southern San Luis Obispo Counties, California, Spring 1969 to Spring 1970. May 8, 1972. 27 pages.

22. Open-File Report, Ground Water Conditions During 1968, Vandenberg Air Force Base, California. February 8, 1970. 20 pages.

Miscellaneous

23. Max Bookman and Robert Edmonston (Consulting Civil Engineers), Water Requirements of Santa Barbara County, 1967-1990. February 1968. (Unpublished.) Pp. 12-13, 16, 18-20, 25-28, 30-32.

SCHUMANN CANYON BASIN - BASIN 178

Location	Near the community of Casmalia.
Bibliography	Items 1, 5, 9, 15. Pages 242-243.
Description	Alluvium-filled basin extending east from the coast. Area: 1.7 square miles. Coastline: 1,800 feet.
Water Use	Dry-farmed hay and grain for stock grazing.
Water-bearing Sediments	Ground water stored in unconsolidated Recent alluvium and probably in dune sand near the coast. Thickness and physical characteristics unknown.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water occurred about 4 miles inland during the summer of 1955. This area was also noted in the spring 1970 sampling. It may be derived from underlying formations. Ground water is probably moving in a seaward direction.

Table 114. MINERAL ANALYSIS, BASIN 178, SCHUMANN CANYON

Item	Ground Water
	Lester Muscio Well
Base Meridian	San Bernardino
Location Number	9N/35W-23R1
Date Sampled	5-29-70
Character	$NaHCO_3$
Temperature (°F)	64
Specific Conductance (micromhos at 25° C)	1,954
pH	7.2
CONSTITUENTS, in parts per million	
Total Dissolved Solids	1,245
Total Hardness as $CaCO_3$	253
Bicarbonate: HCO_3	339
Boron	1.28
Calcium	43
Carbonate: CO_3	0
Chloride	200
Fluoride	0.68
Magnesium	36
Nitrate: NO_3	124
Potassium	2
Sodium	322
Sulfate: SO_4	294

Santa Barbara County

SAN ANTONIO CREEK VALLEY - BASIN 179

Location	3 miles north of the community of Purisima Point.
Bibliography	Items 1, 5, 9, 15, 20, 22, 23. Pages 242-243.
Description	Alluvium-filled valley that extends east from the coast and is covered by an extensive area of dune sands. Area: 90 square miles. Coastline: at least 1,800 feet.
Water Use	Coastal area largely undeveloped. No observed use of surface or ground water. Ground water is unconfined.
Water-bearing Sediments	Ground water is stored in relatively fine-grained unconsolidated Recent alluvium that is shown by well logs to be probably 90 feet thick near the coast. At inland locations, ground water is derived from the Paso Robles formation and from Careaga sand. At depths of 50 to 250 feet, ground water storage capacity is 2,100,000 acre-feet and usable storage capacity is 300,000 acre-feet. Safe annual yield is estimated to be 7,000 acre-feet.
Ground Water Barriers	Consolidated Tertiary sediments lying about nine miles from shore may form a barrier to ground water movement.
Offshore Geology	Alluvium continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	Ground water in the coastal area contains total dissolved solids that exceed 3,000 ppm and may contain chlorides that exceed 100 ppm. From the limited data available, there is no evidence of sea-water intrusion. In January 1958 a seaward hydraulic gradient existed in the entire basin.

SANTA YNEZ RIVER VALLEY - BASIN 180

Location	Near the community of Surf.
Bibliography	Items 1, 11, 13, 14, 16, 19, 20, 22. Pages 242-243.
Description	A large westward-trending alluvium-filled valley. Area: 260 square miles. Coastline: 1.2 miles.
Water Use	Principally developed for truck crops and flower raising. Numerous irrigation and domestic wells.
Water-bearing Sediments	Near the coast the alluvium is about 200 feet thick. Ground water is stored in younger alluvium having two members, the lower one of which is the main water-bearing zone, and in unconsolidated river channel deposits. Terrace deposits lying above the water table transmit water to underlying permeable formations: Orcutt sand, which is tapped by a few wells, and the Paso Robles formation, which is less permeable than the alluvium, and Careaga sand, which contains no wells. At depths of 20 to 250 feet, the ground water storage capacity is 2,700,000 acre-feet. Usable storage capacity is 362,000 acre-feet. Net safe yield per year is estimated to be 42,800 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	Alluvium continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water in the coastal part of the valley containing chlorides from 250 to 500 ppm may be derived from mixing with either--or possibly both--concentrated salts from irrigation water or older saline water in underlying marine sediments. The area was also found to be degraded in 1955. Ground water elevations in this area lie above sea level and a seaward hydraulic gradient exists. However, although sea-water intrusion is not believed to cause this degradation, a threat of intrusion will exist if water levels along the coast fall below sea level for any extended period of time. Ocean tides travel upstream for more than one mile during dry seasons and, when wells are being heavily pumped, degradation of ground water may occur. Water levels declined about 1.8 feet between November 1967 and November 1968.

Table 115. MINERAL ANALYSIS, BASIN 180, SANTA YNEZ RIVER VALLEY

Item	Ground Water: Santa Barbara County Domestic Well (nondrinking)
Base and Meridian	San Bernardino
Location Number	7N/35W-18J1
Date Sampled	3-19-71
Character	NaCl
Temperature (°F)	64
Specific Conductance (micromhos at 25° C)	7,463
pH	8.0
CONSTITUENTS, in parts per million	
Total Dissolved Solids	4,598
Total Hardness as $CaCO_3$	989
Bicarbonate: HCO_3	542
Boron	1.07
Calcium	111
Carbonate: CO_3	0
Chloride	2,117
Fluoride	0.48
Magnesium	173
Nitrate: NO_3	6
Potassium	47
Sodium	1,214
Sulfate: SO_4	219

Santa Barbara County

LOMPOC TERRACE* - BASIN 181

Location	5.5 miles north of Point Arguello.
Bibliography	Items 1, 5, 9, 14. Pages 242-243.
Description	An elevated terrace containing Bear Creek Valley, a small alluvium-filled valley extending southeast from the coast. Area of terrace: 7.5 square miles. Coastline of valley: about 500 feet. Coastline of terrace: 3 miles.
Water Use	Undeveloped area proposed for use as a military reservation.
Water-bearing Sediments	Sand dunes, about 300 feet of Orcutt sand (Pleistocene), and a thick section of Careaga sand (Pliocene) comprise the principal water-bearing materials. Shallow and impermeable alluvium in Bear Canyon is underlain at depth by Tertiary sediments. About 60,000 acre-feet of usable ground water is stored in deposits that lie above sea level.
Ground Water Barriers	Unnamed faults form the north and south boundaries of consolidated rocks. No barriers exists on the ocean side.
Offshore Geology	Water-bearing materials at the shoreline that are possibly several hundred feet thick continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	Test drilling has shown that degraded water contains chlorides ranging from 180 to 300 ppm. Source of this poor quality water is unknown. In September 1958 ground water in the basin was moving seaward.

*Formerly Bear Creek Basin.

Table 116. MINERAL ANALYSIS, BASIN 181, LOMPOC TERRACE

Item	Ground Water
Character	NaCl
Total Dissolved Solids (ppm)	550 - 1,150
Chlorides (ppm)	180 - 300

SPRING CANYON BASIN - BASIN 182

Location	4 miles north of Point Arguello.
Bibliography	Items 1, 5, 9, 14, Pages 242-243.
Description	An area of sand dunes and older water-bearing materials overlain by the Spring Canyon alluvium-filled valley. Area: 3.0 square miles. Coastline: possibly 500 feet. (Length is undetermined because the area is covered in part by windblown sand and in part by exposed Monterey formation rocks lying above sea level.
Water Use	No development of surface or ground water.
Water-bearing Sediments	Sand dunes and the shallow alluvium-filled valley of Spring Creek are underlain by Orcutt sand of Pleistocene age whose thickness and physical characteristics are unknown, although the base of these water-bearing materials probably lies above sea level throughout most of the area. The Orcutt sand is underlain by siliceous and diatomaceous shale of Monterey formation (Miocene age).
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

CANADA HONDA BASIN - BASIN 183

Location	2 miles north of Point Arguello.
Bibliography	Items 1, 5, 9, 14. Pages 242-243.
Description	Alluvium-filled valley extending east from the coast. Area: 0.01 square mile. Coastline: length unknown; may be about 400 feet.
Water Use	No development of surface or ground water.
Water-bearing Sediments	Unconsolidated river floodplain deposits of unknown thickness and physical characteristics are underlain by consolidated siliceous shale of Monterey formation. Most water-bearing materials lie in the upper portion of the valley.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Santa Barbara County

JALAMA BASIN - BASIN 184

Location	5 miles northwest of the community of Conception.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending northeast from the coast. Area: 0.02 square mile. Coastline: 750 feet.
Water Use	Jalama County Park occupies part of the coast; the remainder is undeveloped. Surface water is used to water stock that is raised at inland locations.
Water-bearing Sediments	Unconsolidated river floodplain and terrace deposits of unknown thickness and physical characteristics. Valley is underlain by diatomaceous shale of Sisquoc formation and siliceous and diatomaceous shale of Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water with a chloride concentration that exceeds 500 ppm (shown by 1970 sampling). Source of the degradation has not been established. Ground water is probably moving seaward.

Table 117. MINERAL ANALYSIS, BASIN 184, JALAMA BASIN

Item	Ground Water
	Jalama County Park Well
Base and Meridian	San Bernardino
Location Number	5N/34W-18L1
Date Sampled	12-8-70
Temperature (°F)	95
Field EC	2,750
pH	7.9
Chlorides (ppm)	690

COJO BASIN - BASIN 185

Location	1 mile east of the community of Conception.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.5 square mile. Coastline: 1,200 feet.
Water Use	Coastal part of the basin is developed to dry-farmed hay and grain. Several wells are used for irrigation. Surface water is used to water stock. Drinking water is piped down from the hills to the east.
Water-bearing Sediments	Unconsolidated river floodplain and terrace deposits of unknown thickness and physical characteristics. Valley is underlain by diatomaceous shale of Sisquoc formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water with a chloride concentration exceeding 100 ppm. Chlorides in similar concentrations were found in samples taken in summer, 1954. The source of this degradation has not been established. Ground water in the area is probably moving seaward.

Table 118. MINERAL ANALYSIS, BASIN 185, COJO BASIN

Item	Ground Water
	Fred H. Bixby Ranch Company (not used)
Base and Meridian	San Bernardino
Location Number	4N/34W-3N1
Date Sampled	11-17-70
Temperature (°F)	65
Field EC	2,500
pH	8.1
Chloride (ppm)	250

Santa Barbara County

DAMSITE CANYON BASIN - BASIN 186

Location	1.5 miles east of the community of Conception.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.12 square miles. Coastline: 750 feet.
Water Use	Surface and ground water undeveloped. Area is used for stock grazing.
Water-bearing Sediments	Unconsolidated stream deposits of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

CANADA DEL COJO BASIN - BASIN 187

Location	2 miles east of the community of Conception.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.2 square mile. Coastline: 600 feet.
Water Use	Area is used primarily for cattle grazing. A few small wells supply water to the upper part of the valley.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Santa Barbara County

GATO BASIN - BASIN 188

Location	1.5 miles west of San Augustine.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.15 square mile. Coastline: 650 feet.
Water Use	Developed to dry-farmed grains and hay and to cattle grazing. No development of ground or surface water.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

SAN AUGUSTINE BASIN - BASIN 189

Location	Near San Augustine.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.19 square mile. Coastline: 1,500 feet.
Water Use	Used for cattle grazing. Two wells in the upper part of the valley supply water for domestic use.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	Limited data provides no evidence of sea-water intrusion. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 119. MINERAL ANALYSIS, BASIN 189, SAN AUGUSTINE

Item	Ground Water
	Gaviota Coast Corporation Domestic and Irrigation Well
Base and Meridian	San Bernardino
Location Number	5N/33W-32D1
Date Sampled	12-9-70
Temperature (°F)	71
Field EC	700
pH	8.0
Chloride (ppm)	60

AGUJAS BASIN - BASIN 190

Location	1 mile east of San Augustine.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.15 square mile. Coastline: 1,750 feet.
Water Use	Undeveloped. Area is used for stock grazing.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

BULITO BASIN - BASIN 191

Location	1.3 miles east of San Augustine.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.15 square mile. Coastline: 600 feet.
Water Use	Irrigated fields and scattered residential development. Undeveloped portions used for stock grazing. A few wells in the upper part of the valley constitute an emergency water supply.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

CANADA DE LA BREA BASIN - BASIN 192

Location	1.5 miles west of the community of Drake.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.2 square mile. Coastline: 950 feet.
Water Use	Developed for cattle grazing. A few wells provide an emergency water supply for a ranch in the upper part of the valley.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

CANADA DE SANTA ANITA BASIN - BASIN 193

Location	Near the community of Drake.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.2 square mile. Coastline: 500 feet.
Water Use	Undeveloped. Area is used primarily for stock grazing.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Santa Barbara County

ALEGRIA BASIN - BASIN 194

Location	2 miles east of the community of Drake.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.2 square mile. Coastline: 500 feet.
Water Use	No development of surface or ground water. Area is used for stock grazing.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Santa Barbara County

GAVIOTA BASIN - BASIN 195

Location	1.5 miles west of the community of Gaviota.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.19 square mile. Coastline: 1,000 feet.
Water Use	Coastal part of the area is developed for recreation; the remaining part has been partially cleared for stock raising and ranch buildings. A few wells located in the valley are used for irrigation. Surface water is used for stock watering.
Water-bearing Sediments	Unconsolidated river floodplain, channel and terrace deposits of unknown thickness and physical characteristics. Valley is underlain by siliceous shale and siltstone of Monterey and Rincon formations.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water that occurred in the coastal part of the valley in summer, 1954, and in December 1970 was probably caused by commingling with connate water in older Tertiary sediments. Limited data shows no evidence of intrusion of sea water. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 120. MINERAL ANALYSIS, BASIN 195, GAVIOTA

Item	Ground Water
	Gaviota State Park Domestic and Irrigation Well
Base and Meridian	San Bernardino
Location Number	5N/32W-33H1
Date Sampled	12-9-70
Temperature (°F)	71
Field EC	3,200
pH	7.9
Chlorides (ppm)	750

CEMENTARIO BASIN - BASIN 196

Location	0.75 mile east of the community of Gaviota.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.01 square mile. Coastline: 500 feet.
Water Use	Area is occupied by terminal oil storage tanks and offshore oil loading facilities for Tidewater Associated Oil Company and by the Gaviota Marine Terminal on the coast. Remainder of the valley is undeveloped.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics. Coastal portion of the valley underlain by thin-bedded shale and siltstone of Monterey and Rincon formations.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

CANADA SAN ONOFRE BASIN - BASIN 197

Location	1.75 miles east of the community of Gaviota.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.01 square mile. Coastline: 400 feet.
Water Use	Undeveloped, except for one small ranch near the coast, water supply unknown. Ground and surface water are not used.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics. Coastal portion of the valley underlain by thin-bedded shale and siltstone of Monterey and Rincon formations.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

ARROYO HONDO BASIN - BASIN 198

Location	2 miles west of the community of Tajiguas.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.15 square mile. Coastline: 600 feet.
Water Use	Coastal part of the valley is undeveloped, except for one small ranch. The remainder is used for stock raising and dry farming. Stock are watered with surface water.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and characteristics. The valley is underlain by thin-bedded shale and siltstone of Monterey and Rincon formations.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	Information is insufficient to determine the origin of chlorides that degraded ground water in the coastal part of the valley in January 1971. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 121. MINERAL ANALYSIS, BASIN 198, ARROYO HONDO

Item	Ground Water
	Vincent Ortega Domestic Well
Base and Meridian	San Bernardino
Location Number	5N/31W-32A1
Date Sampled	1-21-71
Temperature (°F)	62
Field EC	1,060
pH	7.4
Chloride (ppm)	121

Santa Barbara County

ARROYO QUEMADO BASIN - BASIN 199

Location	0.75 miles west of the community of Tajiguas.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.1 square mile. Coastline: 400 feet.
Water Use	Area is largely developed for stock raising. A few wells supply water for irrigation and domestic uses. Surface water is used for stock watering.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics. The valley is underlain by thin-bedded shales of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

TAJIGUAS BASIN - BASIN 200

Location	Near the community of Tajiguas.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.5 square mile. Coastline: 400 feet.
Water Use	No development in the coastal part of the valley. The remainder is used for citrus groves and irrigated pasture. A few wells and some surface water are used to water stock.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics. The valley is underlain by thin-bedded shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of ground water with chloride concentrations exceeding 100 ppm occurred in the coastal part of the valley in summer, 1954, and January 1971. The degradation was probably caused by commingling with connate water in underlying older Tertiary formations. Limited data shows no evidence of sea-water intrusion. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 122. MINERAL ANALYSIS, BASIN 200, TAJIGUAS

Item	Ground Water
	A. B. Ruddock Irrigation Well
Base and Meridian	San Bernardino
Location Number	5N/31W-35B1
Date Sampled	1-13-71
Temperature (°F)	72
Field EC	2,600
pH	8.0
Chloride (ppm)	176

CANADA DEL REFUGIO BASIN - BASIN 201

Location	2 miles east of the community of Tajiguas.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.7 square mile. Coastline: 1,500 feet.
Water Use	Coastal part of the valley is developed for recreational use. The remainder is used for walnut and citrus groves, dry-farmed hay and grain, and grazing land for cattle. Scattered wells supply domestic and irrigation needs.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics. Exposed sediments are made up of sandy silt and sand with gravel lenses. The coastal portion of the valley is underlain by thin-bedded shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of ground water with chloride concentrations exceeding 300 ppm occurred in the coastal part of the valley in summer, 1954, and January 1971. The degraded water was probably derived from underlying formations. Chlorides of this quality have occurred historically in the valley. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 123. MINERAL ANALYSIS, BASIN 201
CANADA DEL REFUGIO

Item	Ground Water: State of California, Department of Parks & Recreation Well
Base and Meridian	San Bernardino
Location Number	5N/30W-31N1
Date Sampled	1-13-71
Temperature (°F)	69
Field EC	2,550
pH	7.8
Chloride (ppm)	310

CANADA DEL CORRAL BASIN - BASIN 202

Location	3.5 miles east of the community of Tajiguas.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.04 square mile. Coastline: 550 feet.
Water Use	Coastal part of the valley serves as a terminal for oil storage tanks and associated facilities. The remainder is occupied by oil wells and storage facilities of the Capitan oil field. A few water wells meet irrigation and domestic needs.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics. Exposed sediments are made up of sandy silt and sand with gravel lenses. The coastal portion of the valley is underlain by thin-bedded shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of ground water with chloride concentrations exceeding 220 ppm occurred in the coastal part of the valley in summer, 1954, and January 1971. The degraded water was probably derived from underlying formations. Chlorides of this quality have occurred historically in the valley. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 124. MINERAL ANALYSIS, BASIN 202
CANADA DEL CORRAL

Item	Ground Water: Shell Oil Company Industrial Well
Base and Meridian	San Bernardino
Location Number	5N/30W-32L1
Date Sampled	1-14-71
Temperature (°F)	70
Field EC	1,400
pH	8.2
Chloride (ppm)	220

CAPITAN BASIN - BASIN 203

Location	5 miles east of the community of Tajiguas.
Bibliography	Items 1, 2, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.2 square mile. Coastline: 750 feet.
Water Use	Coastal part of the valley is developed for public recreation. Stock raising occupies the remainder.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics is composed of exposed boulders and cobbles grading to exposed sandy silt and sand with gravel lenses near the mouth of the valley. The coastal portion of the valley is underlain by shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No evidence of intrusion. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 125. MINERAL ANALYSIS, BASIN 203, CAPITAN

Item	Ground Water
	Gila Land Corporation Irrigation and Domestic Well
Base and Meridian	San Bernardino
Location Number	5N/30W-33A1
Date Sampled	1-14-71
Temperature (°F)	68
Field EC	640
pH	7.6
Chloride (ppm)	40

Santa Barbara County

LAS VARAS BASIN - BASIN 204

Location	0.75 mile north of the community of Naples.
Bibliography	Items 3, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.66 square mile. Coastline: 500 feet.
Water Use	Citrus orchards occupy the valley. Scattered wells supply domestic and irrigation needs.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics is composed of exposed sandy silt and sand with discontinuous gravel lenses. The coastal part of the valley is underlain by consolidated mudstone and diatomaceous shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal part of this basin in summer, 1954. Sampling in January 1971 showed no evidence of degraded water.

Table 126. MINERAL ANALYSIS, BASIN 204, LAS VARAS

Item	Ground Water
	John Doty Irrigation Well
Base and Meridian	San Bernardino
Location Number	4N/30W-1B1
Date Sampled	1-19-71
Temperature (°F)	70
Field EC	1,560
pH	7.7
Chloride (ppm)	60

DOS PUEBLOS BASIN - BASIN 205

Location	Near the community of Naples.
Bibliography	Items 3, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.51 square mile. Coastline: 600 feet.
Water Use	Coastal part of the valley is occupied by irrigated pasture and walnut orchards and the remainder, by citrus groves and pasture land. A few abandoned oil wells exist along the shoreline. Inland wells supply most of the water used in the area. Small reservoirs lie at the mouth of Dos Pueblos Creek and along its tributary streams.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics is composed of exposed sandy silt and sand with discontinuous gravel lenses. The coastal portion of the valley is underlain by consolidated mudstone and diatomaceous shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No evidence of intrusion. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 127. MINERAL ANALYSIS, BASIN 205, DOS PUEBLOS

Item	Ground Water
	Signal Oil and Gas Company Domestic and Irrigation Well
Base and Meridian	San Bernardino
Location Number	5N/29W-31Q1
Date Sampled	1-19-71
Temperature (°F)	70
Field EC	890
pH	7.9
Chloride (ppm)	54

Santa Barbara County

EAGLE CANYON BASIN - BASIN 206

Location	6 miles west of the community of Goleta.
Bibliography	Items 3, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.55 square mile. Coastline: 600 feet.
Water Use	Coastal part of the valley is undeveloped and lacks water wells. Scattered development of walnut orchards, pasture land, and dry-farmed grain acreage occupies the inland portions. Terminal oil storage tanks are located on adjacent marine terraces.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics is composed of exposed sandy silt and sand with discontinuous gravel lenses. The coastal part of the valley is underlain by consolidated mudstone and diatomaceous shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Santa Barbara County

TECOLOTE BASIN - BASIN 207

Location	5 miles west of the community of Goleta.
Bibliography	Items 3, 5, 9. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.43 square mile. Coastline: 1,200 feet.
Water Use	Terminal oil storage tanks and offshore oil-loading facilities occupy the beach area. The rest of the valley is developed in part in walnut orchards and irrigated pasture land. Scattered wells supply domestic and irrigation needs.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics is composed of exposed fine-grained sandy silt and sand. The coastal part of the valley is underlain by consolidated mudstone and diatomaceous shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No evidence of intrusion. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 128. MINERAL ANALYSIS, BASIN 207, TECOLOTE

Item	Ground Water
	Irrigation Well
Base and Meridian	San Bernardino
Location Number	4N/29W-4Q1
Date Sampled	1-21-71
Temperature (°F)	68
Field EC	1,280
pH	7.9
Chloride (ppm)	70

Santa Barbara County

BELL CANYON BASIN - BASIN 208

Location	4.75 miles west of the community of Goleta.
Bibliography	Items 3, 5, 9, 12. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.7 square mile. Coastline: 1,000 feet.
Water Use	Terminal oil storage tanks and offshore oil loading facilities occupy the beach area. The rest of the valley is completely developed in walnut and citrus groves and pasture land. Scattered wells supply domestic and irrigation needs.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics is composed of exposed fine-grained sandy silt and sand. The coastal part of the valley is underlain by consolidated mudstone and diatomaceous shale of the Monterey formation.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	An area of ground water with chloride concentrations exceeding 200 ppm occurred in the coastal part of the valley in summer, 1954, and January 1971. The degraded water was probably derived from underlying and adjacent older formations. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 129. MINERAL ANALYSIS, BASIN 208, BELL CANYON

Item	Ground Water
	Hollister Ranch Irrigation and Domestic Well
Base and Meridian	San Bernardino
Location Number	4N/29W-10G1
Date Sampled	1-21-71
Temperature (°F)	73
Field EC	1,850
pH	7.8
Chloride (ppm)	230

CAMPBELL CREEK BASIN - BASIN 209

Location	4 miles southwest of the community of Goleta.
Bibliography	Items 3, 5, 9, 12. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast. Area: 0.59 square mile. Coastline: 4,000 feet.
Water Use	Valley is developed in irrigated citrus groves and in residential areas.
Water-bearing Sediments	Unconsolidated alluvium composed of clay, silt, sand, and and gravel that is up to 250 feet thick and yields moderate amounts of water. These deposits are surrounded by terrace deposits and older alluvium.
Ground Water Barriers	Although the More Ranch fault, which crosses the basin 3 miles north of the coast, could act as a barrier to ground water movement where impermeable formations contact water-bearing strata, there is no evidence that this is the case in this basin.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water occurred about 1.5 miles inland in fall, 1955, and January 1971. Chloride concentrations exceeding 200 ppm were found during the 1971 sampling. The degraded water may have been derived from older sediments underlying the basin. Chlorides of this quality have occurred historically in this area. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 130. MINERAL ANALYSIS, BASIN 209, CAMPBELL CREEK

Item	Ground Water Nat Perkoff Domestic and Irrigation Well
Base and Meridian	San Bernardino
Location Number	4N/29W-14G1
Date Sampled	1-26-71
Temperature (°F)	69
Field EC	1,650
pH	7.7
Chloride (ppm)	212

Santa Barbara County

GOLETA BASIN - BASIN 210

Location	Near the community of Goleta.
Bibliography	Items 3, 9, 12, 18, 20, 23. Pages 242-243.
Description	The basin consists mainly of a central alluvial plain bounded by low hills and terraces and extending 8 miles in an east-west direction. Area: 11 square miles. Coastline: 1 mile.
Water Use	The basin is principally urban but parts have been extensively developed for irrigated crops and pasture. Ground water is used widely to meet domestic needs.
Water-bearing Sediments	Recent and older alluvium and the Santa Barbara formation of Plio-Pleistocene age are the major water-bearing materials. The Recent alluvium, which has a maximum thickness of 250 feet, comprises the valley fill. Its predominant sediments are clay and silt that restrict downward percolation and confine water in the underlying older alluvium and the Santa Barbara formation. The older alluvium contains some coarse members and is tapped by a few wells. The Santa Barbara formation contains coarse, poorly sorted gravel that yields water to many wells. Its maximum thickness is 2,000 feet. At depths of 50 to 250 feet, this formation has the capacity to store 180,000 acre-feet of ground water. Its usable capacity is 17,000 acre-feet. Estimated safe yield is 5,800 acre-feet and current use is 2,000 acre-feet.
Ground Water Barriers	The water-bearing deposits in this basin are separated from the ocean at and below the surface by a continuous formation of impermeable rocks that is broken only at the outlet of two sloughs near Goleta Point. A test well drilled by the U. S. Geological Survey in alluvium near Goleta Slough penetrated only clay and fine silt with a few thin sands. These materials indicate a very low permeability and a limited connection between the basin and the ocean. The More Ranch fault, which crosses the basin about 0.5 mile inland, does not apparently form a barrier to ground water movement.
Offshore Geology	No information available.
Sea-water Intrusion	No evidence of intrusion. Even though ground water levels near the ocean have been considerably below sea level for many years, sampling indicated that no intrusion has yet occurred. Bedrock and fine-grained alluvium near the coast apparently act as effective barriers to landward movement of sea water. Inland from Goleta Slough, near Goleta Point, ground water levels also lie below sea level, but no landward hydraulic gradient has been detected yet. However, limited intrusion may result, if pumping increases and low ground water levels continue.

Sea-water Intrusion (Continued)

Surface salt water extends as much as one mile inland through Goleta Slough and overlies water-bearing deposits in the southern end of the basin. But a deep body of water-bearing materials is not in hydraulic continuity with similar deposits that overlie it.

Table 131. MINERAL ANALYSES, BASIN 210, GOLETA

Item	Ground Water		
	Goleta County Water District		Bishop Ranch
Base and Meridian	San Bernardino	San Bernardino	San Bernardino
Location Number	4N/28W-10F3	4N/28W-15F4	4N/28W-18F2
Date Sampled	9-14-70	9-14-70	9-14-70
Character	$CaHCO_3$	$CaHCO_3$	$CaHCO_3$
Temperature (°F)	66	68	75
Specific Conductance (micromhos at 25° C)	1,036	1,006	1,718
pH	8.0	7.8	7.7
CONSTITUENTS, in parts per million			
Total Dissolved Solids	708	685	1,095
Total Hardness as $CaCO_3$	462	448	481
Bicarbonate: HCO_3	337	334	526
Boron	0.07	0.05	0.48
Calcium	126	120	107
Carbonate: CO_3	0	0	0
Chloride	52	42	168
Fluoride	0.5	0.5	0.4
Magnesium	36	36	52
Nitrate: NO_3	1.4	14	16
Potassium	1	1	18
Sodium	56	51	198
Sulfate: SO_4	218	204	241

HOPE BASIN - BASIN 211

Location	4 miles east of Goleta Point and 4 miles west of the city of Santa Barbara.
Bibliography	Items 3, 5, 9, 12. Pages 242-243.
Description	Alluvium-filled valley extending north from the coast and merging inland with older water-bearing sediments of Basin 210. Area: 0.55 square mile. Coastline: 350 feet.
Water Use	The valley is occupied by a private estate. A few acres have been developed as pasture for horses. Very little use is made of water resources.
Water-bearing Sediments	Unconsolidated alluvium composed of clay, silt, sand, and gravel of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available for the coastal part of the valley. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

SAN ROQUE BASIN - BASIN 212

Location	2 miles west of the city of Santa Barbara
Bibliography	Items 3, 5, 9, 12, Pages 242-243.
Description	Alluvium-filled valley extending north from the coast and merging inland with water-bearing materials in Basin 210 and Basin 213. Area: 0.31 square mile. Coastline: 500 feet.
Water Use	The valley is occupied by private residences, some irrigated crops, and a few wells. A public beach has been developed at the mouth of San Roque Basin.
Water-bearing Sediments	Unconsolidated alluvium composed of clay, silt, sand, and gravel of unknown thickness and physical characteristics. The valley is underlain by the Santa Barbara and Monterey formations.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information available for the coastal part of the valley. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 132. MINERAL ANALYSIS, BASIN 212, SAN ROQUE

Item	Ground Water: C. H. Williams Ranch Domestic and Irrigation Well
Base and Meridian	San Bernardino
Location Number	4N/27W-18C1
Date Sampled	6-4-70
Character	$CaNaSO_4HCO_3$
Temperature (°F)	62
Specific Conductance (micromhos at 25° C)	998
pH	7.2
CONSTITUENTS, in parts per million	
Total Dissolved Solids	650
Total Hardness as $CaCO_3$	390
Bicarbonate: HCO_3	221
Boron	0.21
Calcium	99
Carbonate: CO_3	0
Chloride	54
Fluoride	0.78
Magnesium	35
Nitrate: NO_3	1.5
Potassium	3.5
Sodium	67
Sulfate: SO_4	258

Santa Barbara County

SANTA BARBARA BASIN - BASIN 213

Location	In the city of Santa Barbara, at the eastern end of Basin 210.
Bibliography	Items 3, 9, 12, 17, 20, 23. Pages 242-243.
Description	Low-lying section of the coast that occupies a small alluvial plain and a larger terraced area, 2 miles wide, that bounds the plain. Area: 9 square miles. Coastline: 2 miles.
Water Use	Domestic water imported from the Santa Ynez River for residential use comprises the major use of water in the basin. Some agricultural acreage depends on ground water for irrigation.
Water-bearing Sediments	Younger alluvium, older alluvium, and the Santa Barbara formation of Plio-Pleistocene age, having a combined maximum thickness of 2,000 feet, comprise the water-bearing materials in the basin. Clay and silt with lenses of sandy clay and gravel form the younger alluvium. The older alluvium consists of red and yellow clay and sandy clay with lenses of sand and gravel. The Santa Barbara formation consists of sand, silt, clay, some marl, and gravel deposited as lenses and stringers. Practically all water pumped from the basin occurs in the lower part of the younger alluvium and in the Santa Barbara formation. In the younger alluvium, these bodies are confined by impermeable beds underlying most of the alluvial plain. At depths ranging to about 250 feet, total ground water storage capacity is about 184,000 acre-feet. Estimated safe yield is about 2,000 acre-feet.
Ground Water Barriers	Consolidated rocks along part of the Mesa fault, which extends northwest from the coast, have been lifted above sea level on the seaward side of the fault and effectively seal water-bearing deposits from sea water. A north-south ground water divide is used in this report to separate this basin and Basin 214.
Offshore Geology	No information available.
Sea-water Intrusion	Intrusion in the coastal part of this basin appears to have been limited to shallow deposits lying directly adjacent to the coast. Less permeable offshore deposits have most probably held the invasion of sea water to a minimum. Well sampling in 1962 and 1970 provided evidence that several areas of ground water were degraded by chloride concentrations higher than 100 ppm. Chlorides in other wells occurred at or below that level. Only deep wells built without an

Sea-water Intrusion (Continued)

adequate cement seal between the casing and the aquifer appear to have become degraded. In earlier years before 1960 wells flowed at the surface but since then water levels near the coast have fallen below sea level. Although there is no positive indication that a landward hydraulic gradient has been established, increased pumping will threaten intrusion.

Table 133. MINERAL ANALYSES, BASIN 213, SANTA BARBARA

Item	Ground Water		
	Santa Barbara Cemetery Well	City of Santa Barbara Municipal Wells	
Base and Meridian	San Bernardino	San Bernardino	San Bernardino
Location Number	4N/27W-13R1	4N/27W-14R1	4N/27W-15Q9
Date Sampled	6-4-70	7-28-70	9-14-70
Character	$CaNaClHCO_3$	-	$CaHCO_3$
Temperature (°F)	72	-	68
Specific Conductance (micromhos at 25° C)	3,108	900	947
pH	6.5	7.0	8.1
CONSTITUENTS, in parts per million			
Total Dissolved Solids	2,114	590	609
Total Hardness as $CaCO_3$	1,044	320	379
Bicarbonate: HCO_3	366	-	234
Boron	0.22	-	0.01
Calcium	258	84	96
Carbonate: CO_3	0	-	0
Chloride	737	65	101
Fluoride	0.41	0.5	0.5
Magnesium	97	26	34
Nitrate: NO_3	4.8	1	46.5
Potassium	5	3	1
Sodium	237	85	50
Sulfate: SO_4	186	165	112

Santa Barbara County

MONTECITO AREA* - BASIN 214

Location	At the community of Montecito, 3 miles east of the city of Santa Barbara.
Bibliography	Items 3, 9, 12, 17. Pages 242-243.
Description	Low-lying section of the coast. Area: 6 square miles. Coastline: 2 miles.
Water Use	Chiefly for residences; some for irrigated agriculture.
Water-bearing Sediments	Unconsolidated alluvium, the Casitas formation of Pleistocene age, and the Santa Barbara formation of Plio-Pleistocene age together may be about 900 to 1,000 feet thick. Total ground water storage capacity to a depth of 250 feet is about 281,000 acre-feet. Safe yield is estimated to be about 2,000 acre-feet.
Ground Water Barriers	Consolidated rocks along the coast that appear to be thrust above rocks in the basin act as a barrier to ground water movement. A north-south ground water divide is used in this report to separate this basin and Basin 213.
Offshore Geology	No information available.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal part of this basin in 1964. High chlorides in a deep well in that area are probably derived from shallow aquifers that were not properly sealed.

*Formerly Oriegas Basin

CARPINTERIA BASIN - BASIN 215

Location	In and adjacent to the city of Carpinteria.
Bibliography	Items 3, 9, 12, 18, 23. Pages 242-243.
Description	A low-lying alluvial plain bounded by hills and terraces, extending about 8 miles west along the coast from the Ventura County line at Rincon Creek almost to Loon Point and north from the coast for 2 miles. Area: 12 square miles. Coastline: 4.8 miles.
Water Use	Developed largely for residential acreage and citrus orchards. Domestic needs are served by water imported from the Santa Ynez River and ground water is pumped extensively for irrigation.
Water-bearing Sediments	Younger alluvium, older alluvium, the Casitas formation of Pleistocene age, and the Santa Barbara formation of Plio-Pleistocene age, having a combined thickness of 2,000 feet, comprise the water-bearing materials in the basin. In some areas, alluvial silt and clay confine the water in underlying deposits.

The older alluvium is composed of clay, sand, and gravel and yields water only in moderate amounts. If wells penetrate lenses of coarse material in younger alluvium, they become fair producers. The Casitas formation, which comprises a hilly and terraced area bordering the eastern part of the alluvial plain, consists of poorly sorted clay, silt, sand, and gravel. This formation supplies water to many wells east of Rincon Creek and along Gobernador Creek. To the south it is finer grained and yields less water. The Santa Barbara formation is composed of thick beds of fine sand and silt that underlie a steeply sloping area east of Rincon Creek. It is penetrated by a few wells.

Ground water in the basin occurs in two separate bodies. A shallow body lying principally in the upper part of the younger alluvium is chiefly unconfined and supplies a few domestic wells. The main body lies several hundred feet deep in the lower part of the younger alluvium and in the Casitas and Santa Barbara formations. Lying nearly coextensive with the formations in which it is contained, this body is confined by impermeable beds in the younger alluvium beneath most of the alluvial plain. It supplies water to all irrigation wells.

Ground water storage capacity at depths of 50 to 250 feet is about 140,000 acre-feet and usable capacity is about 19,000 acre-feet. Estimated safe yield is 3,400 acre-feet and current use is 3,200 acre-feet.

Ground Water Barriers — None is known near the coast; however, aquifers may become less permeable just offshore. Where consolidated rocks have been lifted above sea level along the seaward side of faults that trend inland, an effective barrier is created.

Offshore Geology — No information available.

Sea-water Intrusion — Although ground water levels along the coast have been below sea level for several years and as much as 40 feet below sea level recently, present pumping activity has brought no apparent adverse effects. Increased pumping may threaten intrusion of sea water, however. There is no indication that a seaward hydraulic gradient has been established. Most probably offshore sediments having poor permeability are failing to transmit sea water to the basin in sufficiently large amounts to affect ground water quality.

Table 134. MINERAL ANALYSES, BASIN 215, CARPINTERIA

Item	Ground Water		
	Moses Mesa Water Company Municipal Well	Carpinteria Water Company Municipal Wells	
Base and Meridian	San Bernardino	San Bernardino	San Bernardino
Location Number	4N/25W-26B2	4N/25W-28N3	4N/25W-29D3
Date Sampled	9-14-70	9-14-70	9-14-70
Character	$CaNaHCO_3SO_4$	$CaNaHCO_3SO_4$	$CaNaHCO_3SO_4$
Temperature (°F)	77	68	66
Specific Conductance (micromhos at 25° C)	853	1,258	829
pH	7.9	8.3	7.9
CONSTITUENTS, in parts per million			
Total Dissolved Solids	559	843	503
Total Hardness as $CaCO_3$	381	523	338
Bicarbonate: HCO_3	290	416	347
Boron	0.04	0.23	0.04
Calcium	103	132	91
Carbonate: CO_3	0	0	0
Chloride	39	93	28
Fluoride	0.4	0.6	0.6
Magnesium	30	47	27
Nitrate: NO_3	12.2	0.8	4.3
Potassium	2	5	1
Sodium	40	90	56
Sulfate: SO_4	153	232	126

CHAPTER VI

SOUTHERN COASTAL BASINS

Ventura County
Los Angeles County
Orange County
San Diego County

VENTURA COUNTY

Figure 24. STATUS OF SEA-WATER INTRUSION, VENTURA COUNTY 1970-1971

VENTURA COUNTY

The five identified ground water basins in coastal Ventura County lie in valley-fill alluvium and older water-bearing materials. They cover about 97 square miles and are open to the Pacific Ocean along about 22 miles of coastline. The Oxnard Plain (Basin 218), the major ground water storage area, covers 73 square miles.

In Basin 218, ground water occurs in a thick section of water-bearing materials about 1,500 feet thick near Port Hueneme. Several major aquifers in this section have been identified: the Oxnard aquifer of Recent age; the Mugu aquifer of Upper Pleistocene age; and Hueneme, Fox Canyon, and Grimes aquifers of Lower Pleistocene age.

Total estimated storage capacity of ground water in Ventura River Valley to a depth of 100 feet is 20,000 acre-feet; 5,000 acre-feet is estimated to be usable. Onshore storage capacity of Oxnard Plain is 9,000,000 acre-feet.

The Oxnard Plain basin, where the base of the water-bearing sediments along the coast attains a maximum depth of 1,800 feet at the shoreline, offers a location for storage of large quantities of fresh water in offshore aquifers. Recent geologic studies indicate that these sediments extend beneath the continental shelf for great distances and contain an additional 8,000,000 acre-feet of fresh water, of which 5,500,000 acre-feet is considered recoverable.

Minor quantities of water for domestic use may be obtainable in Miocene sedimentary and volcanic rocks along the coast south of the Santa Clara River Valley where weathering, jointing, and fracturing have created some secondary porosity and permeability. These areas were not covered in the statewide inventory.

Table 135. STATUS OF SEA-WATER INTRUSION, VENTURA COUNTY

Basin		1953-55	1970-71
No.	Name		
216	Ventura River Valley	Chlorides exceed 100 ppm	No change as of 1969
217	Mound	No apparent sea-water intrusion	No change
218	Oxnard Plain	Known sea-water intrusion	Area increasing
219	Big Sycamore	Chlorides exceed 100 ppm	No change
220	Little Sycamore	No apparent sea-water intrusion	No change

BIBLIOGRAPHY

Ventura County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, Los Angeles Sheet. 1969.

California Department of Water Resources

2. Bulletin No. 46, Ventura County Investigation--1933. April 1934. Pp. 96, 99, 117-118.

3. Bulletin No. 46-A, Ventura County Investigation--1933: Basic Data. April 1934. 586 pages.

4. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-23, 33-34, Plate 13.

5. Status of Sea-Water Intrusion. December 1960. Pp. 181-186. (Unpublished; drafted as Appendix A of Bulletin No. 63.)

6. Bulletin No. 63-1, Sea-Water Intrusion, Oxnard Plain of Ventura County. October 1965. 100 pages. Plate 2.

7. Bulletin No. 63-4, Sea-Water Intrusion: Aquitards in the Coastal Ground Water Basin of Oxnard Plain, Ventura County. September 1971. 569 pages.

8. Bulletin No. 66, Quality of Ground Waters in California. April 1960. Pp. 27-28, Plate 5.

9. Bulletin No. 66-58, Quality of Ground Waters in California. November 1960. Pp. 27-29, Plate 5.

10. Bulletin No. 66-59, Quality of Ground Waters in California. February 1963. Pp. 25-32, Plate 4.

11. Bulletin No. 66-60, Quality of Ground Waters in California; Part II, "Southern California". March 1964. Pp. 25-32, Plate 4.

12. Bulletin No. 66-62, Quality of Ground Waters in California; Part II, "Southern California". September 1964. Pp. 16-19, Plate 4.

13. Bulletin No. 74-9, Water Well Standards: Ventura County. August 1968. 84 pages. Figure 3.

14. Bulletin No. 75, Water Quality and Water Quality Problems, Ventura County. February 1959. Pp. 28-32, 82-102, 164-168, Plate 15.

15. Bulletin No. 130 Series, Hydrologic Data: Volume V, Southern California. Appendixes C, D, and E. 1963 through 1971.

16. Bulletin No. 147-6, Ground Water Basin Protection Projects, Oxnard Basin Experimental Extraction-Type Barrier. September 1970. Pp. 32-34.

17. Bulletin No. 160-70, Water for California, The California Water Plan: Outlook in 1970. December 1970. 179 pages.

18. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

California State Water Resources Control Board

19. Bulletin No. 12, Ventura County Investigation, Volume I. October 1953 (revised April 1956). Pp. 2-129 to 2-133.

U. S. Geological Survey

20. Water Supply Paper 1619-S, Geology and Ground Water Appraisal of the Naval Air Missile Test Center Area, Point Mugu, California. 1963. 40 pages.

21. Open-File Report, Progress Report on Water Supply for the Point Mugu Naval Base, Ventura County, California. 1948. 51 pages.

22. Open-File Report, Data on Water Wells, Naval Air Missile Test Center, Point Mugu, California. 1960. 98 pages.

23. Open-File Report, Ground Water Conditions During 1959 at the Naval Air Missile Test Center, Point Mugu, California. 1961. 32 pages.

24. Open-File Report, Ground Water Conditions During 1960 at the U. S. Naval Air Station, Point Mugu, California. 1961. 58 pages.

25. Open-File Report, Proposed Water Resources Study of the Lower Santa Clara River - Oxnard Plain Area, California. December 4, 1968. 52 pages.

26. Open-File Report, Ground-Water Data as of 1967; South Coastal Subregion, California. March 5, 1969. Pp. 6-7.

27. Open-File Report, Geology of Western Ventura Basin - Oxnard Plain Offshore Area and its Relationship to the Ground Water Basins and Salt Water Intrusion. 1971. 111 pages.

Miscellaneous

28. Bruington, A. Saltwater Intrusion in the United States. Proceedings, American Society of Civil Engineers, Hydraulic Division Journal. September 1969. HY5, No. 6788, page 1657.

29. Gorsline, Donn S. Report of a Reconnaissance Survey of the Hydrographic Characteristics of the Hueneme-Mugu Shelf to Evaluate Ground Water Leakage from Submarine Exposure of Coastal Aquifers, June-July 1970. University of Southern California, Department of Geological Sciences, USC Geol. Report No. 70-6. July 31, 1970. 21 pages.

VENTURA RIVER VALLEY - BASIN 216

Location	North and west of the City of Ventura.
Bibliography	Items 1, 2, 5, 14, 18. Pages 288-289.
Description	A constriction near Foster Park divides the basin into upper and lower sections. Area of lower basin: 3.9 square miles. Coastline: 1 mile.
Water Use	Lower basin is occupied by homes and farms and oil production and refining facilities. Only a few wells are present.
Water-bearing Sediments	Principal aquifers in the lower basin are sand and gravel members of Recent and Upper Pleistocene alluvium that are about 100 feet thick. These bodies are recharged from the Ventura River and contain poor quality water. Permeable beds in the San Pedro formation containing good quality water are recharged from more distant areas. Ground water storage capacity at depths up to 100 feet is about 20,000 acre-feet. Usable storage capacity is about 5,000 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	The alluvium continues offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	In the coastal part of the valley, an area of degraded ground water occurred in 1955 and chlorides exceeded 1,100 ppm in May 1969. This degradation may have been due to intrusion of sea water along the coast, but farther inland it was probably caused by the intrusion of oil field brines. Very few wells obtain water from the alluvium in the lower basin and only limited data were therefore available to determine the status of intrusion. If intrusion has taken place, it has not as yet adversely affected the quality of ground water in the underlying San Pedro formation. Limited data indicate that a seaward hydraulic gradient exists.

Table 136. MINERAL ANALYSES, BASIN 216, VENTURA RIVER VALLEY

Item	Ground Water	
	Continental Oil Co.	Taylor Ranch
Base and Meridian	San Bernardino	San Bernardino
Location Number	2N/23W-5L1	2N/23W-5P1
Date Sampled	5-29-69	5-29-69
Temperature (°F)	70	70
Specific Conductance (micromhos at 25° C)	4,440	4,502
pH	7.5	7.5
Chloride (ppm)	1,190	1,190
Total Dissolved Solids (ppm)	3,172	3,160

MOUND BASIN - BASIN 217

Location	Between the city of Ventura and the Santa Clara River.
Bibliography	Items 1, 2, 5, 14, 18, 27. Pages 288-289.
Description	Ground surface slopes from hills in the northern portion toward the Santa Clara River and the ocean. Elevations range from sea level to 400 feet. Area: 19.4 square miles. Coastline: 4.5 miles.
Water Use	The basin is extensively developed for truck crops and citrus orchards and for industrial, commercial, and residential use. There are numerous irrigation, domestic, municipal, and industrial wells.
Water-bearing Sediments	The principal materials are the Recent and Upper Pleistocene alluvium, which ranges from 100 to 500 feet and contains occasional lenses of sand and gravel, and the 4,000-foot-thick San Pedro formation, which lies unconformably beneath the alluvium and contains gravel, sand, silt, and clay. The upper 500 to 1,000 feet of the San Pedro formation contain many permeable sand and gravel members. The essentially impervious Santa Barbara formation underlies the San Pedro formation.
Ground Water Barriers	None known. Underflow to the south into Oxnard Plain (Basin 218) has not been accurately defined.
Offshore Geology	West of the Ventura River, south-dipping beds of the San Pedro formation strike westward into and beneath the ocean. Hydraulic continuity may exist between those beds and the ocean.
Sea-water Intrusion	Intrusion is not evident. The hydraulic gradient is moving seaward. Wells in the coastal part of the basin display artesian flows when ground water levels are high.

Table 137. MINERAL ANALYSIS, BASIN 217, MOUND BASIN

Item	Ground Water
	Union Oil Company
Base and Meridian	San Bernardino
Location Number	2N/23W-23G1
Date Sampled	5-29-69
Character	$CaNaSO_4$
Temperature (°F)	67
Specific Conductance (micromhos at 25° C)	1,226
pH	8.2
CONSTITUENTS, in parts per million	
Total Dissolved Solids	927
Total Hardness as $CaCO_3$	474
Bicarbonate: HCO_3	271
Boron	0.39
Calcium	129
Carbonate: CO_3	0
Chloride	46
Fluoride	0.6
Magnesium	37
Nitrate: NO_3	0
Potassium	4
Sodium	106
Sulfate: SO_4	399

OXNARD PLAIN BASIN - BASIN 218

Location	4 miles south of the city of Ventura; bounded on the north along the Santa Clara River by Basin 217 and on the south by nonwater-bearing rocks in the Transverse Ranges. The basin extends eastward about 10 miles.
Bibliography	Items 1, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29. Pages 288-289.
Description	Comprised of sediments contributed by the Santa Clara River and other streams that drain the adjacent highland areas. Ground surface elevations range from sea level to 100 feet. Area: 73 square miles. Coastline: about 16 miles.
Water Use	The basin is extensively developed for industry, commerce, residences, military facilities, and such agriculture as truck crops and citrus groves. Several hundred irrigation, domestic, municipal and industrial wells occupy the area. Historically, ground water has been the only source of water, but within the last few years water has been imported.
Water-bearing Sediments	The highly-permeable and confined Oxnard aquifer of Recent age, with a maximum thickness of 160 feet, is considered to be the most important water-bearing deposit in the basin. Ground water in the upper portions of the Recent alluvium is semi-perched and unconfined, with water levels lying above sea level throughout the basin. Upper Pleistocene alluvium contains the Mugu aquifer, which is confined, highly permeable, and no more than 250 feet thick. The San Pedro formation (Lower Pleistocene age) is composed of the Hueneme aquifer, which is confined, moderately to highly permeable, and no more than 300 feet thick. The Fox Canyon aquifer occupies the basal portion of the Lower Pleistocene. The Santa Barbara formation (Lower Pleistocene age) contains the Grimes Canyon aquifer, which is confined, probably moderately permeable, and more than 1,500 feet thick. This aquifer is tapped by only a few wells.
Ground Water Barriers	Some aquifers apparently become thinner and perhaps disappear near the coast, forming a partial barrier to ground water movement. No other barriers are known.
Offshore Geology	The water-bearing deposits extend offshore a distance of many miles. Two submarine canyons, Hueneme and Mugu, have been incised into the offshore sediments exposing the water-bearing sediments in the walls of the canyons. Sea water can enter these sediments where exposed on the canyon walls.
Sea-water Intrusion	In spring, 1968, salt water having a 500-ppm chloride ion concentration had intruded near Port Hueneme a distance of 2.25 miles inland and at Mugu, about 2 miles inland. Increased

Sea-water Intrusion (cont.)

pumping from the Oxnard aquifer has been the major cause of intrusion at Port Hueneme. Water levels in the coastal area of the confined aquifers have been below sea level for many years. A landward hydraulic gradient has existed since 1948. Some attempt to raise water levels in the basin and thus restrain the rate of encroachment of sea water has been made for a period of years by a local agency involved in artificial recharge of inland areas adjacent to Oxnard Plain.

Table 138. MINERAL ANALYSES, BASIN 218, OXNARD PLAIN

Item	Ground Water						
	John Petit Well	---	Kalof Pulp and Paper Company Industrial Well	Frank McGrath Irrigation Well	Frank Brucker Irrigation Well	Hollywood Beach Resort Municipal Well	Joe Friedrich Irrigation Well
Base and Meridian	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino
Location Number	1N/22W-22A1	1N/22W-22C1	1N/22W-28H3	1N/22W-7H1	1N/22W-14K1	1N/22W-18E1	1N/22W-35C1
Date Sampled	3-3-67	3-3-67	9-17-70	12-1-70	11-20-70	11-21-69	12-28-70
Character	-	-	-	$CaNaSO_4HCO_3$	$CaNaSO_4HCO_3$	$CaNaSO_4HCO_3$	$CaNaSO_4HCO_3Cl$
Temperature (°F)	-	-	-	-	-	-	-
Specific Conductance (micromhos at 25° C)	1,712	1,604	-	1,294	1,222	1,124	1,970
pH	-	-	-	-	-	7.8	-
CONSTITUENTS, in parts per million							
Total Dissolved Solids	-	-	-	970	1,037	861	1,377
Hardness as $CaCO_3$							
Total	-	-	-	-	-	449	-
Noncarbonate	-	-	-	-	-	257	-
Percent Sodium	-	-	-	-	-	27	-
Bicarbonate: HCO_3	-	-	-	248	264	234	298
Boron	-	-	-	0.67	0.70	0.70	0.63
Calcium	-	-	-	123	145	118	172
Carbonate: CO_3	-	-	-	-	-	0.	-
Chloride	241	172	81	42	54	37	272
Fluoride	-	-	-	0.7	0.6	0.04	0.6
Magnesium	-	-	-	45	48	38	65
Nitrate: NO_3	-	-	-	-	-	1.0	-
Potassium	-	-	-	-	-	5	-
Sodium	-	-	-	96	94	79	150
Sulfate: SO_4	-	-	-	420	459	358	386

Ventura County

BIG SYCAMORE BASIN - BASIN 219

Location	12 miles southeast of the community of Port Hueneme.
Bibliography	Items 1, 5, 18. Pages 288-289.
Description	Alluvium-filled valley extending north from the coast. Area: 0.62 square mile. Coastline: 2,000 feet.
Water Use	Aside from several commercial establishments and residences situated near the coast, pasture land occupies the basin. A few wells and a spring supply water for stock.
Water-bearing Sediments	Loosely consolidated sands and gravels make up Recent stream and floodplain deposits of unknown thickness and physical characteristics. These are underlain and surrounded by consolidated Tertiary sandstone and shale of the Topanga formation and by volcanic rock.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	Chloride concentrations greater than 100 ppm, which have occurred historically in this basin, were found in an area of degraded ground water in the coastal part in fall, 1955, and in spring, 1971. This high chloride water is believed to have originated from underlying formations. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient throughout the basin.

Table 139. MINERAL ANALYSIS, BASIN 219, BIG SYCAMORE

Item	Ground Water: California Division of Highways, District No. 7 Domestic and Industrial Well
Base and Meridian	San Bernardino
Location Number	1S/20W-19B1
Date Sampled	5-17-71
Temperature (°F)	68
Field EC	1,390
pH	7.5
Chloride (ppm)	148

LITTLE SYCAMORE BASIN - BASIN 220

Location	10 miles west of Point Dume.
Bibliography	Items 1, 5, 18. Pages 288-289.
Description	Alluvium-filled valley extending north from the coast. Area: 0.1 square mile. Coastline: 450 feet.
Water Use	Most of the valley is developed as a campsite. Several small residences are also present.
Water-bearing Sediments	Loosely consolidated sands and gravels make up Recent stream and floodplain deposits of unknown thickness and physical characteristics. These are underlain and flanked by consolidated Tertiary sandstone and shale of the Topanga formation.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient throughout the basin.

Table 140. MINERAL ANALYSIS, BASIN 220, LITTLE SYCAMORE

Item	Ground Water
	Little Sycamore Ranch
Base and Meridian	San Bernardino
Location	1S/20W-14K1
Date Sampled	5-17-71
Temperature (°F)	71
Field EC	1,250
pH	8.0
Chloride (ppm)	40

LOS ANGELES COUNTY

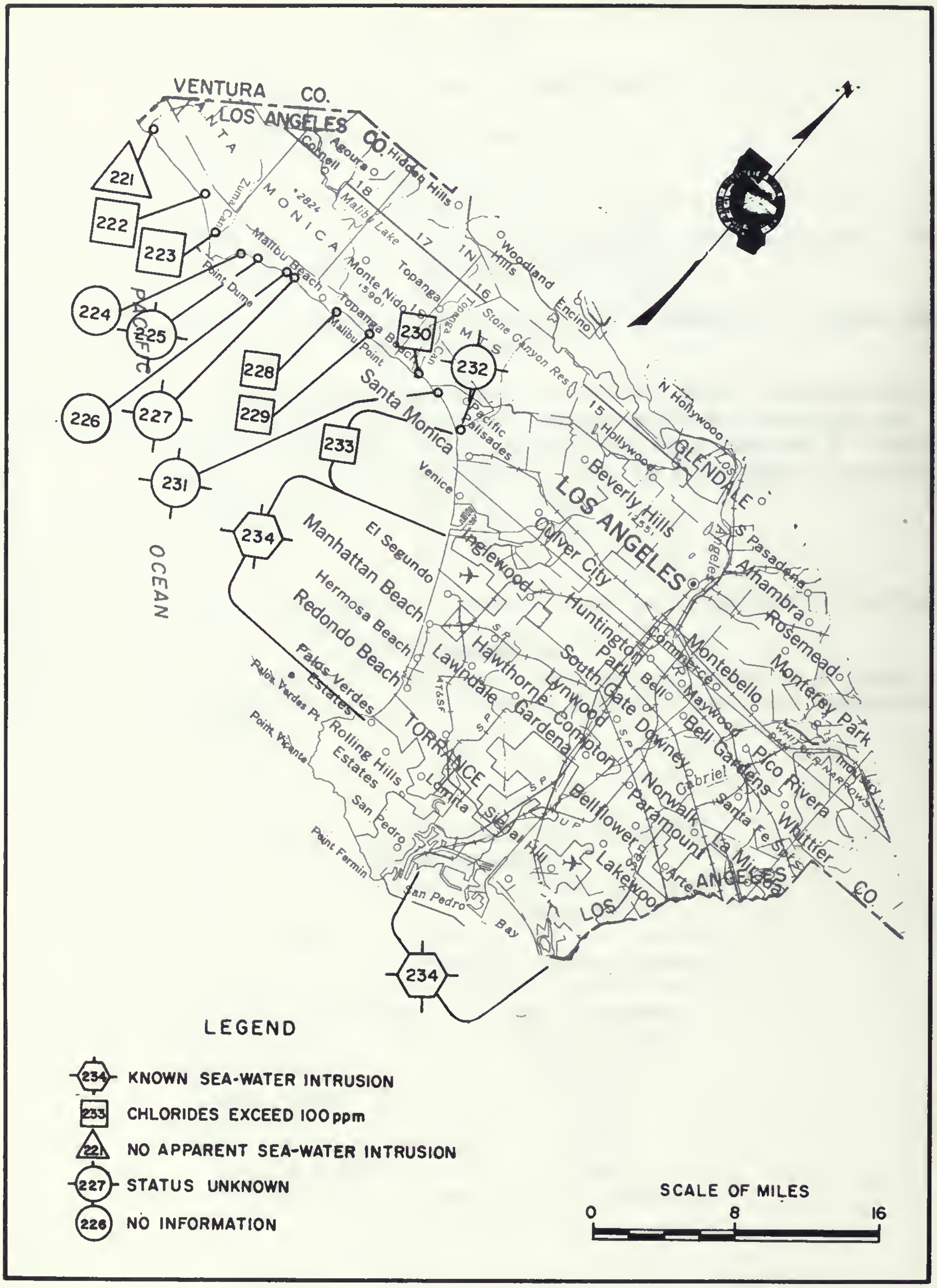


Figure 25. STATUS OF SEA-WATER INTRUSION,
LOS ANGELES COUNTY
1970-1971

LOS ANGELES COUNTY

The 14 identified ground water basins in coastal Los Angeles County lie in valley-fill alluvium and older water-bearing materials. They cover about 194 square miles and are open to the Pacific Ocean along about 19 miles of coastline. The major ground water storage areas are Basin 233, covering 47 square miles, and Basin 234, covering 144 square miles.

Ground water in the major storage areas, Basins 233 and 234, occurs in 1,100-foot-thick section of Quaternary water-bearing material. These basins together cover 191 square miles. They contain several major identified aquifers: the Gaspur water-bearing zone and "50-foot" gravel of Recent age, the "200-foot" sand and Gardena water-bearing zone of Upper Pleistocene age, and the "440-foot" gravel and Silverado water-bearing zone of Lower Pleistocene age.

Shallow discontinuous coastal marine terrace deposits north of Santa Monica may store some ground water. There is no estimate of ground water storage capacity in the coastal valleys of Los Angeles County.

Aquifers offshore from Basin 234 offer the most probable storage for fresh water. There the base of Quaternary water-bearing sediments along the coast lies about 1,100 feet below sea level near San Pedro Bay and more than 500 feet below sea level north of the Palos Verdes Hills. Geologic studies indicate that these sediments extend beneath the continental shelf for an indeterminate distance. Early accounts by local fishermen suggest that offshore fresh-water springs existed before ground water was pumped heavily in coastal land areas. By 1915 fresh water being pumped from wells near Hermosa Beach was showing evidence of saline degradation from sea water moving inland through the offshore extension of Quaternary aquifers.

Along the coast northwest of Santa Monica, where jointing, fracturing and weathering have created some secondary porosity and permeability in the Middle and Late Tertiary sedimentary rock units, minor quantities of water for domestic use may be obtainable. This area is not included in the statewide inventory. Sea-water intrusion in Basin 234 has been stabilized by 93 injection wells operating along the 11 miles between Palos Verdes Hills and Venice.

Table 141. STATUS OF SEA-WATER INTRUSION, LOS ANGELES COUNTY

Basin		1953-55	1970-71
No.	Name		
221	Arroyo Sequit	No apparent sea-water intrusion	No change
222	Trancas	No apparent sea-water intrusion	Chlorides exceed 100 ppm
223	Zuma Canyon	Chlorides exceed 100 ppm	No change
224	Ramera	Chlorides exceed 100 ppm	No information
225	Escondido Canyon	Status unknown	Status unknown
226	Solstice	No apparent sea-water intrusion	No information
227	Corral Canyon	Status unknown	Status unknown
228	Malibu	Chlorides exceed 100 ppm	No change as of 1969
229	Las Flores	Chlorides exceed 100 ppm	No change
230	Topanga	No apparent sea-water intrusion	Chlorides exceed 100 ppm
231	Santa Ynez Canyon	Status unknown	Status unknown
232	Santa Monica Canyon	Status unknown	Status unknown
233	West Coastal Plain-North	Chlorides exceed 100 ppm	No change
234	West Coast Basin	Known sea-water intrusion	Intrusion front stabilized by fresh water injection barrier

BIBLIOGRAPHY

Los Angeles County

<u>California Department of Conservation, Division of Mines and Geology</u>

1. Geologic Map of California, Long Beach Sheet. 1962.

2. Geologic Map of California, Los Angeles Sheet. 1969.

<u>California Department of Water Resources</u>

3. Bulletin No. 63, <u>Sea-Water Intrusion in California</u>. November 1958. Pp. 19-21, 34-37, Plate 16.

4. <u>Status of Sea-Water Intrusion</u>. December 1960. Pp. 186-199. (Unpublished; drafted as Appendix A of Bulletin No. 63.)

5. Bulletin No. 66, <u>Quality of Ground Waters in California</u>. April 1960. Pp. 29-30, Plate 6.

6. Bulletin No. 66-58, <u>Quality of Ground Waters in California</u>. November 1960. Pp. 29-31, Plate 6.

7. Bulletin No. 66-59, <u>Quality of Ground Waters in California</u>; Part II, "Southern California." February 1963. Pp. 33-37, Plate 5.

8. Bulletin No. 66-60, <u>Quality of Ground Waters in California</u>; Part II, "Southern California". March 1964. Pp. 33-39, Plate 5.

9. Bulletin No. 66-62, <u>Quality of Ground Waters in California</u>. September 1964. Pp.19-24, Plate 5.

10. Bulletin No. 74-4, <u>Water Well Standards: Central, Hollywood, Santa Monica Basins; Los Angeles County</u>. (Final supplement) August 1968. 16 pages.

11. Bulletin No. 104, <u>Planned Utilization of Ground Water Basins, Coastal Plain of Los Angeles County</u>. September 1968. 32 pages.

12. Bulletin No. 104, <u>Planned Utilization of Ground Water Basins, Coastal Plain of Los Angeles County; Appendix A, Ground Water Geology</u>. June 1961. 196 pages.

13. Bulletin No. 104, <u>Planned Utilization of Ground Water Basins, Coastal Plain of Los Angeles County</u>; <u>Appendix B, Safe Yield Determinations</u>. April 1962. 142 pages.

14. Bulletin No. 104, <u>Planned Utilization of Ground Water Basins, Coastal Plain of Los Angeles County</u>; <u>Appendix C, Operation and Economics</u>. December 1966. 454 pages.

15. Bulletin No. 107, <u>Recommended Well Construction and Sealing Standards for Protection of Ground Water Quality in West Coast Basin, Los Angeles County</u>. August 1962. 122 pages.

16. Bulletin No. 130 Series, Hydrologic Data; Volume V, Appendixes C, D, and E. 1963 through 1971.

17. Bulletin No. 160-70, Water for California, the California Water Plan: Outlook in 1970. December 1970. 179 pages.

18. West Coast Basin Reference; Draft of Report of Referee. Superior Court, State of California, County of Los Angeles. No. 506806. February 1952. 175 pages.

19. Bulletin No. 179 Series, Watermaster Service in the West Coast Basin: Los Angeles County. 1968 through 1973.

20. Files: Basic Data, Sea Water Intrusion Inventory. 1970 and 1971.

U. S. Geological Survey

21. Water Supply Paper 1136, Native and Contaminated Ground Waters in the Long Beach-Santa Ana Area, California. 1953. 320 pages.

22. Water Supply Paper 1461, Geology, Hydrology, and Chemical Character of Ground Waters in the Torrance-Santa Monica Area, California. 1959. 425 pages.

23. Open-File Report, Ground Water Data as of 1967, South Coastal Subregion, California. March 5, 1969. Pp. 6-7.

Miscellaneous

24. Bruington, A. Saltwater Intrusion in the United States. Proceedings, American Society of Civil Engineers. Hydraulic Division Journal, HY5, No. 6788. September 1969. P. 1657.

ARROYO SEQUIT BASIN - BASIN 221

Location	8 miles west of Point Dume.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending north from the coast. Area: 0.14 square mile. Coastline: 900 feet.
Water Use	Coastal part of the valley is owned by the California Department of Parks and Recreation. Little ground or surface water is used.
Water-bearing Sediments	Loosely consolidated sands and gravels make up Recent stream alluvium of unknown thickness and physical characteristics. Adjacent and underlying rocks consist of consolidated Tertiary sandstones and shales of the Topanga formation.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No evidence of intrusion. Fresh-water inflow may be sufficient to maintain a seaward hydraulic gradient throughout the basin.

Table 142. MINERAL ANALYSIS, BASIN 221, ARROYO SEQUIT

Item	Ground Water: California Department of Parks and Recreation
Base and Meridian	San Bernardino
Location Number	1S/20W-25E1
Date Sampled	5-18-71
Temperature (°F)	69
Field EC	1,075
pH	7.6
Chloride (ppm)	58

Los Angeles County

TRANCAS BASIN - BASIN 222

Location	2.5 miles west of Point Dume.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending north from the coast. Area: 0.2 square mile. Coastline: 1,000 feet.
Water Use	Other than several commercial establishments and small homes situated along the coast, pasture land occupies the valley. The Malibu Water Company owns a number of wells there.
Water-bearing Sediments	Recent alluvium consists of loosely consolidated sands and gravels ranging in thickness from 0 to 100 feet. The coastal part of the valley is flanked by terrace deposits composed of loosely consolidated sands and gravels. The remainder is underlain and flanked by consolidated Tertiary rocks.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	In 1971 an area of degraded ground water with chlorides exceeding 100 ppm occurred near the coast. In 1950 definite evidence existed that a landward hydraulic gradient was causing intrusion. This was later corrected when a seaward gradient was again established. If water levels once more fell below sea level, intrusion would be immediately threatened.

Table 143. MINERAL ANALYSIS, BASIN 222, TRANCAS

Item	Ground Water: Malibu Water Company Municipal Well
Base and Meridian	San Bernardino
Location Number	1S/19W-35Q2
Date Sampled	5-18-71
Temperature (°F)	65
Field EC	1,140
pH	7.6
Chloride (ppm)	150

Los Angeles County

ZUMA CANYON BASIN - BASIN 223

Location	1 mile west of Point Dume.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending north from the coast. Area: 0.35 square mile. Coastline: 500 feet.
Water Use	Valley is occupied by small farms and homes and a coastal bathing beach. Wells supply domestic and municipal water.
Water-bearing Sediments	Recent alluvium consisting of sands and gravels ranges from 0 to 100 feet thick. Terrace deposits lie along the edges of the valley. Modelo shales flank and underlie the alluvium.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water with chlorides exceeding 100 ppm occurred in the coastal part of the valley in December 1954 and May 1971. The high chlorides may be derived from underlying older formations. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient throughout the basin.

Table 144. MINERAL ANALYSIS, BASIN 223, ZUMA CANYON

Item	Ground Water Malibu Water Company Municipal Well
Base and Meridian	San Bernardino
Location Number	2S/18W-6M2
Date Sampled	5-19-71
Temperature (°F)	60
Field EC	1,250
pH	8.0
Chloride (ppm)	165

RAMERA BASIN - BASIN 224

Location	1 mile east of Point Dume.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending northwest from the coast. Area: 0.10 square mile. Coastline: 320 feet.
Water Use	Valley is occupied by small homes. The coastal portion is developed for swimming and fishing and a trailer park.
Water-bearing Sediments	Sand, silt, and gravel compose Recent stream alluvium of unknown thickness and physical characteristics. The valley is flanked by terrace deposits and underlain by Modelo shale.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An inland area of degraded water with chlorides exceeding 100 ppm that occurred in December 1954 was probably derived from the Modelo formation. No information was available in 1971. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient throughout the basin.

ESCONDIDO CANYON BASIN - BASIN 225

Location	2 miles east of Point Dume.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending north from the coast. Area: 0.05 square mile. Coastline: 250 feet.
Water Use	Stock grazing; some nonirrigated pasture land.
Water-bearing Sediments	Sand, silt, and gravel compose Recent alluvium and Quaternary terrace deposits of unknown thickness and physical characteristics. Modelo shale underlies these deposits.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level in the coastal part of the valley and to maintain a seaward hydraulic gradient throughout the basin.

SOLSTICE BASIN - BASIN 226

Location	3.5 miles west of Malibu Lake.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending northwest from the coast. Area: 0.08 square mile. Coastline: 600 feet.
Water Use	Except for some homes, pasturage occupies the valley. A small dam on Solstice Creek impounds a water supply.
Water-bearing Sediments	Silt, sand, and gravel compose Recent alluvial deposits of unknown thickness and physical characteristics that are flanked and underlain by Modelo shale.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level in the coastal part of the valley and to maintain a seaward hydraulic gradient throughout the basin.

CORRAL CANYON BASIN - BASIN 227

Location	South of Malibu Lake.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending north from the coast. Area: 0.05 square mile. Coastline: 400 feet.
Water Use	One small cattle ranch and several small homes occupy the valley. Stock is watered from Corral Creek.
Water-bearing Sediments	Recent alluvial deposits of unknown thickness and physical characteristics are underlain by Modelo shale.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to hold ground water levels in the coastal part of the valley at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

MALIBU BASIN - BASIN 228

Location	10 miles west of the City of Santa Monica.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending north from the coast. Area: 0.90 square mile. Coastline: 5,000 feet.
Water Use	The valley is predominately devoted to growing of truck crops and flowers. Residential development, particularly along the coast, is extensive.
Water-bearing Sediments	Recent stream alluvium and floodplain deposits throughout the basin and lagoonal deposits at the lower end form the water-bearing materials. Thickness of the alluvium ranges from 90 feet at the upper end to more than 140 feet at the lower end. Coastal terraces are underlain and surrounded by sandstones, shales, and volcanics of the Modelo, Topanga, and Sespe formations.
Ground Water Barriers	The Malibu Coast fault, which crosses the valley about 2,800 feet inland, evidently does not act as a barrier to the movement of ground water.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	Limited data for this basin indicates that ground water is generally moving seaward, but rapid fluctuation of water levels along the coast permits ocean water to move landward at times. Sea-water intrusion is a continuing threat whenever water levels in the area fall below sea level. This occurred in 1950, and again in 1960, when sea water advanced 0.5 mile inland. In December 1954 and April 1969, chlorides concentrations exceeding 100 ppm were found in ground water in the coastal part of the basin.

Table 145. MINERAL ANALYSIS, BASIN 228, MALIBU BASIN

Item	Ground Water J. Takahashi Irrigation Well
Base and Meridian	San Bernardino
Location Number	1S/17W-32F4
Date Sampled	4-24-67
Specific Conductance (micromhos at 25° C)	1,939
pH	7.4
Chloride (ppm)	218
Total Dissolved Solids (ppm)	1,310

Los Angeles County

LAS FLORES BASIN - BASIN 229

Location	7 miles west of the City of Santa Monica.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending north from the coast. Area: 0.05 square mile. Coastline: 600 feet.
Water Use	The area is occupied by small residential properties. A few small wells have been developed.
Water-bearing Sediments	Recent alluvium of unknown thickness and physical characteristics is underlain by the Martinez formation.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water with chlorides exceeding 100 ppm that occurred in the coastal part of the valley in May 1971 was probably derived from underlying formations. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 146. MINERAL ANALYSIS, BASIN 229, LAS FLORES

Item	Ground Water
	Deerpath Water Company Municipal Well
Base and Meridian	San Bernardino
Location Number	1S/17W-35E1
Date Sampled	5-25-71
Temperature (°F)	68
Field EC	3,500
pH	7.4
Chloride (ppm)	282

Los Angeles County

TOPANGA BASIN - BASIN 230

Location	4 miles west of the City of Santa Monica.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending north from the coast. Area: 0.11 square mile. Coastline: 375 feet.
Water Use	Several commercial establishments are situated along the coast and residential development occupies the rest of the valley. Well water serves the upper part of the valley and wells belonging to the Topanga Mutual Water Association serve the lower part. There is little use of surface water.
Water-bearing Sediments	Recent stream alluvium is at least 45 feet thick. Along the coast it is underlain by consolidated sandstone and conglomerate of the Martinez formation.
Ground Water Barriers	There is no evidence that a large fault crossing the valley about 3,600 feet acts as a barrier to ground water movement.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water with chlorides exceeding 100 ppm that occurred in May 1971 is probably derived from underlying formations. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 147. MINERAL ANALYSIS, BASIN 230, TOPANGA

Item	Ground Water Topanga Water Company Domestic Well
Base and Meridian	San Bernardino
Location Number	1S/16W-32G1
Date Sampled	5-25-71
Temperature (°F)	66
Field EC	1,720
pH	7.5
Chloride (ppm)	126

SANTA YNEZ CANYON BASIN - BASIN 231

Location	2 miles northwest of the City of Santa Monica.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending northeast from the coast. Area: 0.10 square mile. Coastline: 700 feet.
Water Use	Coastal part is developed for recreation and the rest for homes. No apparent use of ground water.
Water-bearing Sediments	Unconsolidated river floodplain and terrace deposits are underlain by consolidated sandstones and shales of the Martinez and Chico formations.
Ground Water Barriers	A small fault that crosses the valley about 1,800 feet inland and other faults that cross farther upstream evidently do not act as barriers to ground water movement in the unconsolidated deposits.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient throughout the basin.

SANTA MONICA CANYON BASIN - BASIN 232

Location	1.5 miles northwest of the City of Santa Monica.
Bibliography	Items 1, 3, 4, 20. Pages 301-302.
Description	Alluvium-filled valley extending northeast from the coast. Area: 0.80 square mile. Coastline: 500 feet. (This area may be part of the extensive West Coastal Plain-North, Basin 233, but, because of a lack of subsurface information, this inventory describes it as a separate basin.)
Water Use	Homes and some small businesses and Will Rogers State Park are the chief developments. No apparent use of ground water.
Water-bearing Sediments	The basin comprises unconsolidated alluvial and terrace deposits of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient throughout the basin.

Los Angeles County

WEST COASTAL PLAIN-NORTH - BASIN 233

Location	Coastal part of the county just south of the City of Santa Monica.
Bibliography	Items 1, 2, 3, 10, 20, 22, 23. Pages 301-302.
Description	Eight miles long and averaging 6 miles wide, the basin is bounded on the north by the Santa Monica Mountains, on the east by the Inglewood fault, on the west by Santa Monica Bay, and on the south by the Ballona escarpment. It slopes south from the mountains to Ballona Creek with ground surface elevations ranging from 500 feet above sea level to sea level. Area: 47 square miles. Coastline: 3 miles.
Water Use	A highly developed metropolitan and industrial area with extensive residential subdivisions. Large quantities of water are imported from the Owens and Colorado Rivers and ground water is pumped from numerous domestic, irrigation, municipal, and industrial wells.
Water-bearing Sediments	Two aquifers have been delineated in this basin: the "50-foot" gravel aquifer of Recent and Upper Pleistocene age and the Silverado aquifer of Pleistocene age. The "50-foot" aquifer, essentially flat-lying, dips slightly south and toward the ocean. It underlies the southern part of the basin from the Overland fault to the ocean and is overlain by fine sand, silt, and some clay. The Silverado aquifer, contained in the San Pedro formation, lies unconformably beneath the "50-foot" gravel and a thin aquiclude. Underlying most of the basin, this water-bearing deposit dips gently south from the Santa Monica Mountains and continues into Basin 234 to the south. Water levels in these aquifers are near sea level and slope toward the ocean. Although ground water in the more highly developed southern part of the basin is essentially confined, ground water in areas of the "50-foot" gravel and along the northern part of the basin is unconfined.
Ground Water Barriers	The northwest-trending Overland and Charnock faults partially block east-west ground water movement within the Silverado aquifer. These are the only known structural barriers in this basin.
Offshore Geology	The Santa Monica submarine canyon extends across the continental shelf to within 4 miles of the southern part of the basin. No information is available regarding the possible outcropping of basin aquifers in the canyon or on the ocean floor.

Sea-water Intrusion

High chloride concentrations have been characteristic of this basin for many years. An area of degraded ground water with chlorides exceeding 100 ppm underlay Ballona Gap in December 1954 and in 1971, and an extensive area near the coast is underlain by chlorides exceeding 500 ppm. The source of this degradation could be either sea-water intrusion or pollution by industrial waste, or a combination of the two.

Table 148. MINERAL ANALYSES, BASIN 233, WEST COASTAL PLAIN-NORTH

Item	Ground Water	
	George Mikawa Irrigation Well	H. Kita Irrigation Well
Base and Meridian	San Bernardino	San Bernardino
Location Number	2S/15W-23A6	2S/15W-23C4
Date Sampled	5-27-71	5-27-71
Temperature (°F)	65	69
Field EC	2,600	4,100
pH	7.6	7.9
Chloride (ppm)	490	640

WEST COAST BASIN - BASIN 234

Location	In the coastal part of the county between the Ballona Escarpment and the Los Angeles-Orange County line.
Bibliography	Items 1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 18, 19, 21, 22, 23, 24. Pages 301-302.
Description	Sixteen miles long and averaging 9 miles wide, the basin is a gently rolling, slightly eroded plain bounded on the north by the Ballona Escarpment and on the east by the Newport-Inglewood uplift. Area: 144 square miles. Coastline along Santa Monica and San Pedro Bays: 14 miles.
Water Use	A highly developed metropolitan and industrial area with extensive residential subdivisions. Large quantities of water are imported from the Owens and Colorado Rivers and ground water is pumped from hundreds of domestic, irrigation, municipal, and industrial wells.
Water-bearing Sediments	Three distinct ground water bodies exist in this basin. The principal body includes six types of material (from the topmost): The Gaspur aquifer; an upper fine-grained phase containing semiperched ground water; a coarse water-bearing basal segment called the "200-foot" sand; the Gardena aquifer (all of Upper Pleistocene age); and the "400-foot" gravel and the Silverado aquifer (both of Lower Pleistocene age, San Pedro formation).

The "200-foot" sand, which underlies an area of 84 square miles, varies in thickness from 50 to 75 feet. It is in hydraulic continuity with the Gardena aquifer and merges with the Silverado aquifer along the northern side of the Palos Verdes Hills. The Gardena aquifer, which underlies the central part of the basin, averages 75 feet thick. It is 8 miles long, east to west, and 1.5 to 4.5 miles wide. Lying between the communities of Hermosa Beach and Redondo Beach, the Gardena aquifer merges with the "400-foot" gravel aquifer below it and the "200-foot" sand aquifer above it, as well as the Silverado aquifer.

The "400-foot" gravel is confined and is separated from the Silverado aquifer by a relatively impermeable layer of sandy silt and clay. It is 50 feet thick for much of its area, reaching a maximum thickness of 100 feet near Gardena. The Silverado aquifer, confined in most of its area, ranges from 300 to 500 feet thick in the southern part and from 100 to 200 feet thick in the northern part.

Fine-grained Recent and Upper Pleistocene sediments, which overlie the principal body, make up the second major ground

Water-bearing Sediments (Cont.)	water body in this basin. These materials are discontinuous and unconfined and store semiperched water. The third major body underlies the others and is confined. It consists of chiefly connate saline water that occurs in Tertiary sediments. No estimate of ground water storage capacity for this basin is available. However, the capacity of the entire coastal plain of Los Angeles County, from the 1960 ground water table to a depth of 2,000 feet, is estimated to be 29,360,000 acre-feet.
Ground Water Barriers	The Charnock fault, which extends south from the northern boundary of the basin to the vicinity of Gardena, effectively restricts the east-west movement of ground water in confined aquifers in the northern part of the basin. The Newport-Inglewood uplift contains numerous faults that impede ground water movement along the eastern boundary of the basin.
Offshore Geology	Aquifers are exposed in two locations: within the Redondo submarine canyon, which begins a few hundred feet of the shore at Redondo Beach and extends several miles offshore, and on the ocean floor along most of Santa Monica Bay north of the Palos Verdes Hills. The Gaspur aquifer is in direct hydraulic continuity with the ocean in the Los Angeles Harbor area of San Pedro Bay.
Sea-water Intrusion	A landward hydraulic gradient has existed in the Silverado aquifer since 1932 and, although sea-water intrusion is a continuing problem, degradation of ground water by ocean water has been either stabilized or reversed by a pressure ridge created by injection of fresh water into the merged Silverado-"400-foot" gravel aquifer along the Los Angeles County coastline. The present maximum extent of intrusion north of the Palos Verdes Hills from Redondo Beach to Santa Monica Bay ranges from 2 to 2.5 miles inland. Sea water has intruded even farther inland in the Dominguez Gap area.

Table 149. MINERAL ANALYSES, BASIN 234, WEST COAST

Item	Ground Water					
	Los Angeles County Flood Control Wells					
Base and Meridian	. . . .	San Bernardino	. . . .			
Location Number	3S/14W-7D1	3S/14W-30G1	3S/15W-24H2	3S/15W-25C4	4S/14W-6H1	4S/14W-17E6
Date Sampled	5-9-69	5-27-69	3-27-69	5-20-69	9-10-68	12-4-68
Chloride (ppm)	100	480	757	265	855	100

ORANGE COUNTY

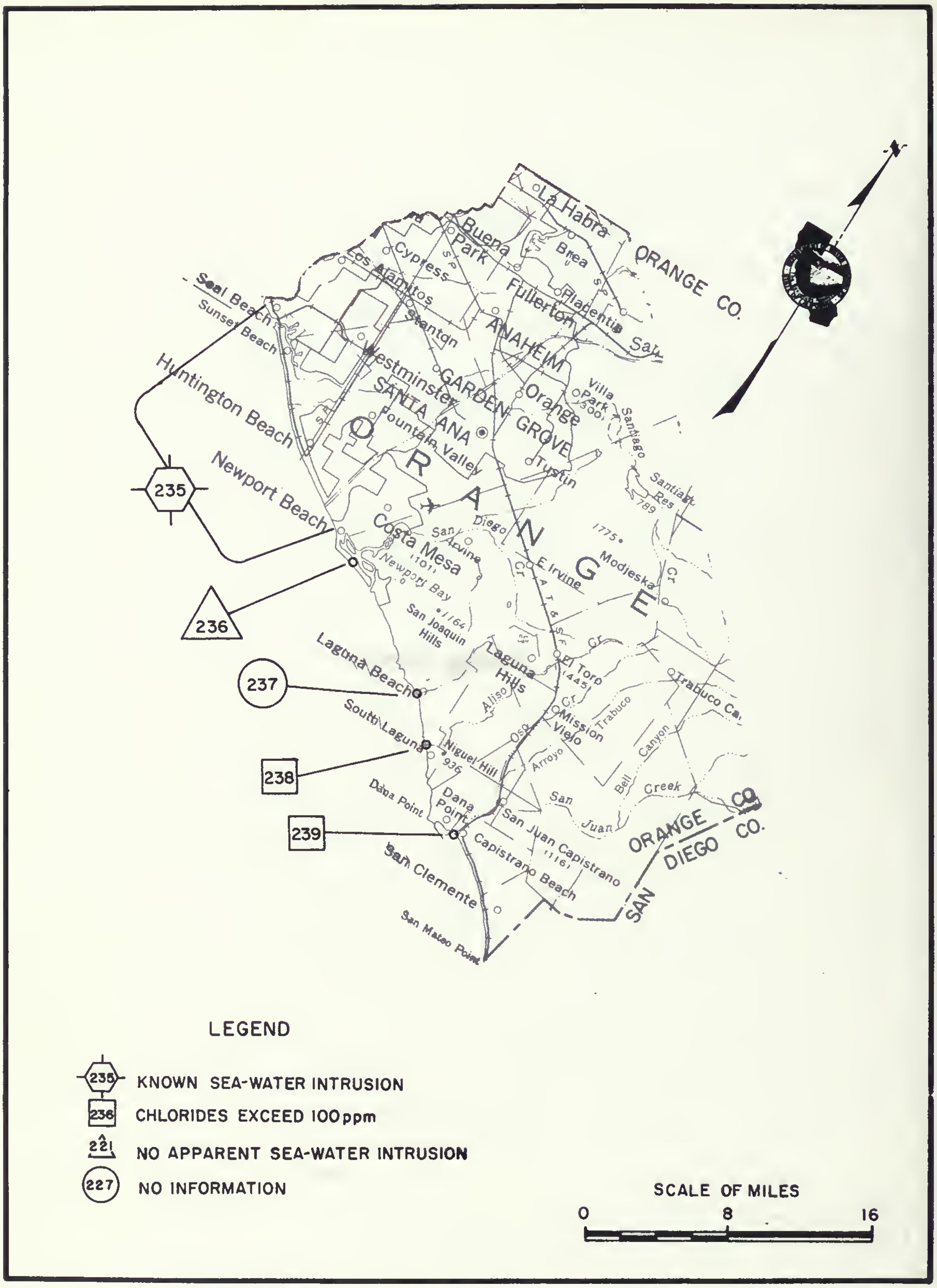


Figure 26. STATUS OF SEA-WATER INTRUSION, ORANGE COUNTY 1970-1971

The five identified ground water basins in coastal Orange County lie in valley-fill alluvium and older water-bearing materials. They cover about 382 square miles and are open to the Pacific Ocean along about 13.6 miles of coastline. Basin 235, extending over 360 square miles, is the major storage area. Basin 239, covering 12.5 square miles, is next in importance.

Basin 235 holds ground water in a section of water-bearing materials that range in thickness from 500 feet along the coast to more than 4,000 feet inland. Several major aquifers have been identified: the Talbert aquifer of Recent age, the La Habra and Lakewood formations of Upper Pleistocene age, the Coyote Hills and San Pedro formation of Lower Pleistocene age, and the Upper Member of the Fernando Group of Pliocene age.

Shallow coastal marine terrace deposits south of Newport Beach may store some ground water.

Total storage capacity in Basin 235 to a depth of about 1,200 feet is an estimated 15,800,000 acre-feet. At depths ranging from 20 to 100 feet, Basin 239 has an estimated total storage capacity of 655,000 acre-feet and an estimated 8,000 acre-feet of usable ground water.

Aquifers offshore from Basin 235, where the base of water-bearing sediments becomes 500 feet thick, are the most probable source of fresh water. Geologic studies suggest that these materials extend beneath the continental shelf for an indeterminate distance. The Newport-Inglewood fault zone, which parallels the entire coastline of the county just inland from the ocean, appears to effectively obstruct ground water movement, chiefly in some of the deeper aquifers, and hence impedes the landward flow of fresh water from offshore aquifers. But buried stream channel deposits of Recent age are unaffected by the fault and permit sea water to move freely inland.

Along the coast south of Newport Beach, where weathering, jointing, and fracturing have created some secondary porosity and permeability in the Miocene sedimentary rocks, minor quantities of water for domestic use may be obtainable. This area is not covered in the statewide inventory.

Table 150. STATUS OF SEA-WATER INTRUSION, ORANGE COUNTY

Basin No.	Basin Name	1953-55	1970-71
235	East Coastal Plain Pressure Area	Known sea-water intrusion	Intrusion front stabilized by injection barrier and artificial recharge
236	Sand Canyon	No apparent sea-water intrusion	No change
237	Laguna Canyon	Chlorides exceed 100 ppm	No information
238	Aliso	Chlorides exceed 100 ppm	No change as of 1969
239	San Juan Valley	Chlorides exceed 100 ppm	No change

BIBLIOGRAPHY

Orange County

California Department of Conservation, Division of Mines and Geology

1. Geologic Map of California, Long Beach Sheet. 1962.

2. Geologic Map of California, Santa Ana Sheet. 1966.

California Department of Water Resources

3. Bulletin No. 15, Santa Ana River Investigation. February 1959. Pp. 43-44

4. Bulletin No. 63, Sea-Water Intrusion in California. November 1958. Pp. 19-21, 37-39, Plate 16.

5. Status of Sea-Water Intrusion. December 1960. Pp. 199-204. (Unpublished; drafted as Appendix A of Bulletin No. 63).

6. Bulletin No. 63-2, Sea-Water Intrusion: Bolsa-Sunset Area. January 1968. 186 pages.

7. Bulletin No. 66, Quality of Ground Waters in California. April 1960. Pp. 53-54, Plate 7.

8. Bulletin No. 66-58, Quality of Ground Waters in California. November 1960. Pp. 60-61, Plate 7.

9. Bulletin No. 66-59, Quality of Ground Waters in California; Part II, "Southern California". February 1963. Pp. 77-83, Plate 10.

10. Bulletin No. 66-60, Quality of Ground Waters in California; Part II, "Southern California". March 1964.

11. Bulletin No. 66-62, Quality of Ground Waters in California; Part II, "Southern California". September 1964. Pp. 42-45, Plate 10.

12. Bulletin No. 70, Orange County Land and Water Use Survey, 1957. January 1959. 84 pages.

13. Bulletin No. 130 Series, Hydrologic Data; Volume V, Southern California. Appendixes C, D, and E. 1963 through 1971.

14. Bulletin No. 147-1, Ground Water Basin Protection Projects: Santa Ana Gap Salinity Barrier, Orange County. December 1966. 194 pages.

15. Bulletin No. 160-70, Water for California, the California Water Plan: Outlook in 1970. December 1970. 179 pages.

16. Progress Report on Ground Water Geology of the Coastal Plain of Orange County. July 1967. 138 pages. Unpublished.

17. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

U. S. Geological Survey

18. Water Supply Paper 1109, Ground-Water Geology of the Coastal Zone, Long Beach-Santa Ana Area, California. 1956. 162 pages.

19. Water Supply Paper 1136, Native and Contaminated Ground Waters in the Long Beach-Santa Ana Area, California. 1953. 320 pages.

20. Water Supply Paper 1471, Hydrology of the Long Beach-Santa Ana Area, California, with Special Reference to the Watertightness of the Newport-Inglewood Structural Zone, with a Section on Withdrawal of Ground Water, 1932-41. 1959. 257 pages.

21. Open-File Report, Status of Salt-Water Contamination in the Coastal Part of Orange County California, as of 1948-49. 1949. 36 pages.

22. Open-File Report, Status of Salt-Water Contamination in the Coastal Part of Orange County, California, as of 1950.

23. Open-File Report, Status of Salt-Water Contamination in the Coastal Part of Orange County, California, as of 1951. 1952. 65 pages.

24. Open-File Report, Summary Statement of Salt-Water Contamination in the Coastal Part of Orange County, California, as of 1952. 1953. 24 pages.

25. Open-File Report, Progress Report on Salt-Water Studies in the Orange County Coastal Area, California. 1965. 37 pages.

26. Open-File Report, Progress Report on the Salt-Water Intrusion Studies, Sunset and Bolsa Gaps, Orange County, California. 1966. 32 pages.

27. Open-File Report, An Investigation of Potential Salt-Water Intrusion from Inland Waterways in the Shallow Alluvial and Coastal Deposits of Sunset and Bolsa Gaps, Orange County, California. 1967. 64 pages.

28. Open-File Report, Ground Water Data as of 1967, South Coastal Subregion, California. March 5, 1969. Pp. 8-9.

29. Open-File Report, A Study of Deep Aquifers Underlying Coastal Orange County, California. March 19, 1969. 27 pages.

30. Open-File Report, Evaluation of Water-Quality Monitoring Network, Orange County Water District, California. August 4, 1969. 56 pages.

Orange County

EAST COASTAL PLAIN PRESSURE AREA - BASIN 235

Location	Bounded by the Los Angeles-Orange County line on the northwest and Newport Beach on the southeast.
Bibliography	Items 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 14, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30. Pages 320-321.
Description	A smooth floodplain underlain by a series of sedimentary formations that vary in thickness from feather edge to more than 20,000 feet. Tongues of alluvium that extend from the plain to the ocean pass between the coastal hills, forming a sequence of mesas and gaps. Area: 360 square miles. Coastline: 12 miles.
Water Use	Agriculture is a major economic activity in the area, but residential subdivision has replaced many citrus and other crops. Other important sources of revenue: oil production and refining; citrus fruit and other food packing; and light and heavy industries. Colorado River water is imported and spread in the Santa Ana River, and since 1973, State Water Project water has also been spread in the Santa Ana River. Ground water is used widely for domestic, industrial, and municipal purposes and for irrigation.
Water-bearing Sediments	Water is contained in three types of sediments: Recent alluvium and deposits of Pleistocene and Pliocene age. The upper portion of the Recent sediments yields limited quantities of water to a few wells; the lower member contains two aquifers, the Talbert Zone in the Santa Ana Gap and the "80-foot" gravel in the Bolsa Gap. Both are moderately to highly permeable. The Upper Pleistocene sediments occur in an upper member and in unsaturated terrace deposits; the Lower Pleistocene (San Pedro formation) is composed of three distinct water zones near the coast whose maximum thickness is 1,050 feet and whose permeability ranges from low to high. The Pliocene deposits (Pico formation) contain confined water that is pumped by a few wells. Maximum thickness of the deposits is 1,400 feet. The aquifers are moderately permeable. Total ground water storage capacity for the entire basin is estimated to be about 40,000,000 acre-feet. Storage capacity in the coastal part of the basin has not been estimated.
Ground Water Barriers	Except in late Recent deposits, the Newport-Inglewood structural zone forms a hydraulic barrier across the basin.

Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	Sea water has intruded 2 to 3 miles into the coastal part of the basin and, in the Alamitos and Santa Ana Gaps and along part of the Newport-Inglewood fault zone southeast of the Los Angeles-Orange County line, it now occupies a greater area than it occupied in 1954-1955. In recent years the rate of advance of sea water has been slowed and the inland landward hydraulic gradient has been flattened by artificial recharge and by partial construction of a sea-water barrier.

Table 151. MINERAL ANALYSES, BASIN 235, EAST COASTAL PLAIN PRESSURE AREA

Item	Ground Water				
	Tom Yanami Irrigation and Domestic Well	Orange County Water District Municipal Well	Santa Ana Country Club Irrigation and Domestic Well	Standard Oil Company Industrial Well	Bolsa Chica Gun Club Domestic and Irrigation Well
Base and Meridian	San Bernardino	San Bernardino	San Bernardino	San Bernardino	San Bernardino
Location Number	5S/10W-9G1	5S/11W-2N1	6S/10W-11G3	5S/11W-26P3	5S/11W-29H1
Date Sampled	9-17-69	4-13-70	4-13-70	5-23-69	5-23-69
Character	-	-	-	$NaHCO_3$	$NaHCO_3$
Temperature (°F)	69	71	-	-	-
Field EC	660	460	400	-	-
Specific Conductance (micromhos at 25° C)	-	-	-	363	334
pH	7.8	7.8	8.1	8.1	8.1
CONSTITUENTS, in parts per million					
Total Dissolved Solids	-	-	-	223	201
Hardness as $CaCO_3$					
Total	-	-	-	19	22
Noncarbonate	-	-	-	0	51
Percent Sodium	-	-	-	89	86
Bicarbonate: HCO_3	-	-	-	182	186
Boron	-	-	-	0.17	0.15
Calcium	-	-	-	6	7
Carbonate: CO_3	-	-	-	1	1
Chloride	46	17	17	14	15
Fluoride	-	-	-	0.6	0.6
Magnesium	-	-	-	1	1
Nitrate: NO_3	-	-	-	1	0
Potassium	-	-	-	1	1
Sodium	-	-	-	78	69
Sulfate: SO_4	-	-	-	20	3

Orange County

SAND CANYON BASIN - BASIN 236

Location	Between Newport Mesa and the San Joaquin Hills.
Bibliography	Items 2, 5, 17. Pages 320-321.
Description	Long, sinuous valley extending north from the coast. The coastal part of the valley is given to tidal marshland. Area: 6.3 miles. Coastline: 0.5 mile.
Water Use	The basin is used principally for recreation, with considerable development of harbor facilities and business establishments and private residences along the shore. Water is imported and distributed by the Metropolitan Water District.
Water-bearing Sediments	Unconsolidated Recent and Upper Pleistocene deposits of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	No information available.
Sea-water Intrusion	No information is available on the extent of intrusion in 1954-55. In February 1971 an area of degraded water with chlorides exceeding 100 ppm occurred about 6 miles inland. Chlorides about this value are historically characteristic of this basin. Ground water is probably moving in a seaward direction. Further development of ground water in and near the basin could reverse the hydraulic gradient and permit brackish or saline water to intrude.

Table 152. MINERAL ANALYSIS, BASIN 236, SAND CANYON

Item	Ground Water: Irvine Ranch Company Irrigation and Stock Well
Base and Meridian	San Bernardino
Location Number	6S/9W-8L1
Date Sampled	2-2-71
Temperature (°F)	71
Field EC	840
pH	8.7
Chloride (ppm)	110

Orange County

LAGUNA CANYON BASIN - BASIN 237

Location	Near the community of Laguna Beach.
Bibliography	Items 2, 5, 17. Pages 320-321.
Description	Alluvium-filled valley extending northeast from the coast. Area: 0.94 square mile. Coastline: 2,100 feet.
Water Use	Urban and recreational development occupy the coast near Laguna Beach. Farther inland are numerous small stock ranches. The coastal part of the basin is served by imported water.
Water-bearing Sediments	Stream-deposited gravels, sands, silts, and clays compose unconsolidated Recent alluvium; marine terrace deposits lie along the coast. Thickness and physical characteristics of these materials is unknown.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	No information is available on intrusion in the coastal part of the basin in 1955 or 1971. However, degraded water with chlorides exceeding 100 ppm occurred in an area about 3 miles inland in 1955. This intrusion probably originated from underlying formations. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient.

Orange County

ALISO BASIN - BASIN 238

Location	Near Aliso Point.
Bibliography	Items 2, 5, 17. Pages 320-321.
Description	Alluvium-filled valley extending northeast from the coast. Area: 2.5 square miles. Coastline: 800 feet.
Water Use	A trailer court and beach facilities have been developed at the coast and a golf and country club is situated farther inland.
Water-bearing Sediments	Thickness and physical characteristics of stream-deposited Recent alluvium are unknown.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal part of the basin in 1957 and fall, 1969. Ground water in this basin having a chloride concentration higher than 100 ppm may be derived from older, underlying Tertiary sediments. Water of this quality is characteristic of the area. Fresh-water inflow is probably sufficient to maintain a seaward gradient.

Table 153. MINERAL ANALYSIS, BASIN 238, ALISO POINT

Item	Ground Water: Laguna Beach County Club Irrigation Well
Base and Meridian	San Bernardino
Location Number	7S/8W-32L2
Date Sampled	10-16-69
Temperature	-
Specific Conductance (micromhos at 25° C)	5,500
pH	7.3
Chloride (ppm)	810

SAN JUAN VALLEY - BASIN 239

Location	1.5 miles southeast of Dana Point.
Bibliography	Items 2, 5, 17, 28. Pages 320-321.
Description	Alluvium-filled valley extending north from the coast. Area: 12.5 square miles. Coastline: 4,000 feet.
Water Use	Irrigated truck and citrus crops and nonirrigated grain occupy the basin. Recreational and camping facilities of Doheny State Park are located along the coast. Many irrigation and domestic wells serve the area. Ground water is unconfined and the water table slopes southwest toward the ocean.
Water-bearing Sediments	Unconsolidated Recent alluvium composed of silt, sand, gravel, and cobbles reaches a maximum thickness of 300 feet. At depths of 20 to 100 feet, ground water storage capacity is an estimated 655,000 acre-feet. Usable storage capacity is an estimated 8,000 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	High chloride ground water with concentrations exceeding 100 ppm that occurred in the coastal part of the basin in 1954, in spring, 1968, and in 1971 may have been derived from older, underlying formation. At present fresh-water inflow is probably sufficient to hold ground water levels at or above sea level. However, if water levels in the coastal portion fall below sea level for an extended length of time, sea-water intrusion will threaten ground water quality.

Table 154. MINERAL ANALYSIS, BASIN 239, SAN JUAN VALLEY

Item	Ground Water	
	Kinoshita Farms Irrigation Well	Kato Bros. Irrigation Well
Base and Meridian	San Bernardino	San Bernardino
Location Number	8S/8W-12L4	8S/8W-14H3
Date Sampled	3-25-68	2-9-71
Temperature (°F)	66	64
Specific Conductance (micromhos at 25° C)	1,620	1,500
pH	8.0	7.9
Chlorides (ppm)	139	390

SAN DIEGO COUNTY

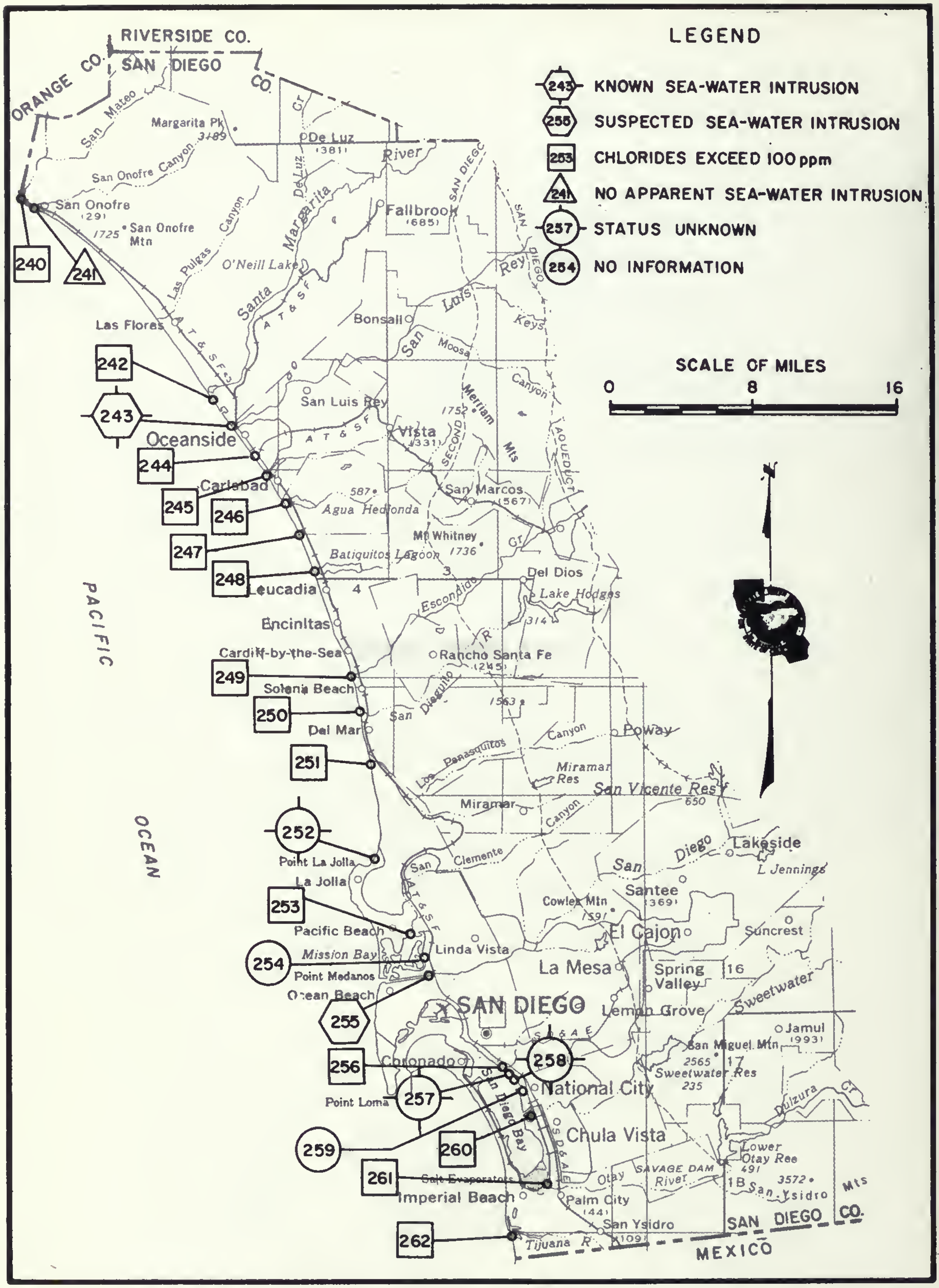


Figure 27. STATUS OF SEA-WATER INTRUSION,
SAN DIEGO COUNTY
1970–1971

SAN DIEGO COUNTY

The 23 identified ground water basins in coastal San Diego County lie in valley-fill alluvium and older water-bearing materials. They cover about 61 square miles and are open to the Pacific Ocean along about 18 miles of coastline. The coastal area contains no large ground water basins. Six of the basins range from 5 to 6.6 square miles and the rest, from 0.39 to 3.6 square miles.

Shallow marine terrace deposits along the entire coastline of the county may store some ground water. Basins 240, 241, 242, 243, and 250 are believed capable of storing a total of about 322,100 acre-feet of ground water in the upper part of their sediments. Their usable storage capacity is estimated to be 102,500 acre-feet. Estimates of storage capacity for the remaining 18 basins are not available. The fresh water storage capability of offshore aquifers is not known.

Minor quantities of water for domestic use may be obtainable from coastal Middle and Late Tertiary sedimentary rocks along the entire coastline where weathering, jointing, and fracturing have created some secondary porosity and permeability. These areas were not covered in the statewide inventory.

Table 155. STATUS OF SEA WATER INTRUSION, SAN DIEGO COUNTY

Basin		1953-55	1970-71
No.	Name		
240	San Mateo Valley	Chlorides exceed 100 ppm	No change
241	San Onofre Valley	Chlorides exceed 100 ppm	Area of chlorides dropped to less than 100 ppm
242	Santa Margarita Valley-Coastal	Chlorides exceed 100 ppm	No change as of 1968
243	San Luis Rey Valley-Mission	Known sea-water intrusion	No change
244	Loma Alta	Chlorides exceed 100 ppm	No change
245	Buena Vista Creek	Chlorides exceed 100 ppm	No change
246	Agua Hedionda	Chlorides exceed 100 ppm	No change
247	Encinas	Chlorides exceed 100 ppm	No change

Table 155. STATUS OF SEA WATER INTRUSION, SAN DIEGO COUNTY (Contd.)

Basin		1953-55	1970-71
No.	Name		
248	San Marcos	Chlorides exceed 100 ppm	No change
249	San Elijo	Chlorides exceed 100 ppm	No change
250	San Dieguito Valley	Chlorides exceed 100 ppm	No change as of 1968
251	Soledad	Chlorides exceed 100 ppm	No change
252	La Jolla	Status unknown	Status unknown
253	Rose Canyon	Chlorides exceed 100 ppm	No change
254	Tecolote Creek	Chlorides exceed 100 ppm	No information
255	San Diego River Valley-Mission	Suspected sea-water intrusion	No change
256	Las Chollas	Chlorides exceed 100 ppm	No change
257	South Las Chollas	Status unknown	Status unknown
258	La Paleta	Status unknown	Status unknown
259	Paradise	Chlorides exceed 100 ppm	No information
260	Sweetwater Valley	Chlorides exceed 100 ppm	No change
261	Otay Valley	Chlorides exceed 100 ppm	No change
262	Tia Juana	Chlorides exceed 100 ppm	No change

BIBLIOGRAPHY

San Diego County

<u>California Department of Conservation, Division of Mines and Geology</u>

1. Geologic Map of California, San Diego-El Centro Sheet. 1962.

2. Geologic Map of California, Santa Ana Sheet. 1966.

<u>California Department of Water Resources</u>

3. Bulletin No. 55, <u>San Dieguito and San Diego Rivers Investigation</u>. June 1949. 258 pages.

4. Bulletin No. 57, <u>Santa Margarita River Investigation</u>. June 1956. Volume I. Pp. 102-104.

5. Bulletin No. 63, <u>Sea-Water Intrusion in California</u>. November 1958. Pp. 19-21, 39-40, Plate 19.

6. <u>Status of Sea-Water Intrusion</u>. December 1960. Pp. 204-223. (Unpublished; drafted as Appendix A of Bulletin No. 63).

7. Bulletin No. 66, <u>Quality of Ground Waters in California</u>. April 1960. Pp. 58-61.

8. Bulletin No. 66-58, <u>Quality of Ground Waters in California</u>. November 1960. Pp. 65-69.

9. Bulletin No. 66-59, <u>Quality of Ground Waters in California</u>; Part II, "Southern California". February 1963. Pp. 99-104, 109-112.

10. Bulletin No. 66-60, <u>Quality of Ground Waters in California</u>; Part II, "Southern California". March 1964. Pp. 98-105, 113-117.

11. Bulletin No. 66-62, <u>Quality of Ground Waters in California</u>; Part II, "Southern California". September 1964. Pp. 52-54, 57-58.

12. Bulletin No. 72, <u>San Dieguito River Investigation</u>. Volume I. November 1959. Pp. 48-49.

13. Bulletin No. 91-18, <u>Water Wells in the San Luis Rey River Valley Area, San Diego County, California</u>. May 1971. 348 pages.

14. Bulletin No. 106-2, <u>Ground Water Occurrence and Quality: San Diego Region</u> Volume I. June 1967. Pp. 91-92, 99-136.

15. Bulletin No. 130 Series, <u>Hydrologic Data</u>: Volume V, Southern California. Appendixes C, D, and E. 1963 through 1971.

16. Bulletin No. 160-70, Water for California, the California Water Plan: Outlook in 1970. December 1970. 179 pages.

17. Special Report No. 1 of Referee, Tijuana Basin. July 1954. Pp. 43-94, Plate 15.

18. Investigation of the Water Quality in Mission Basin San Luis Rey Valley, San Diego County. Project No. 58-9-1, A Report to San Diego Regional Water Pollution Control Board No. 9. May 1958. 40 pages.

19. Ground Water Geology San Diego River Valley; A Progress Report on Investigation of Ground Water Conditions in San Diego River Valley, San Diego County, Project No. 59-9-1. A Report to San Diego Regional Water Pollution Control Board No. 9. December 1959. 35 pages.

20. Division of the Ground Waters of the Tia Juana Basin Between Mexico and the United States. A Report to Governor's Advisory Committee to the United States Section of the International Boundary and Water Commission June 1966. 44 pages.

21. Files: Basic Data, Sea-Water Intrusion Inventory. 1970 and 1971.

California State Water Rights Board

22. Special Report No. 2 of Referee, Tijuana Basin. June 1957. 47 pages.

U. S. Geological Survey

23. Water Supply Paper 446, Geology and Ground Waters of the Western Part of San Diego County, California. 1919. 321 pages.

24. Open-File Report, Ground Water Data as of 1967, South Coastal Region, California. March 5, 1969. Pp. 10-13.

San Diego County

SAN MATEO VALLEY - BASIN 240

Location	3 miles southeast of the community of San Clemente.
Bibliography	Items 2, 6, 14, 21, 23, 24. Pages 333-334.
Description	Alluvium-filled valley extending northeast from the coast. Area: 3.6 square miles. Coastline: 3,600 feet.
Water Use	Several ranches raise irrigated truck crops and nonirrigated hay and grain.
Water-bearing Sediments	Unconsolidated alluvium of unknown physical characteristics may be about 130 feet thick. At depths of 5 to 55 feet, total and usable ground water storage capacity for this basin and Basin 241 may be about 20,500 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal part of the basin in August 1954 and February 1971.

Table 156. MINERAL ANALYSES, BASIN 240, SAN MATEO VALLEY

Item	Ground Water	
	U. S. Marine Corps Irrigation Well	Paul Ecke Domestic and Irrigation Well
Base and Meridian	San Bernardino	San Bernardino
Location Number	9S/7W-11P1	9S/7W-14L1
Date Sampled	2-10-71	2-10-71
Temperature (°F)	65	68
Field EC	580	1,005
pH	9.0	7.9
Chloride (ppm)	37.5	154

SAN ONOFRE VALLEY - BASIN 241

Location	4 miles southeast of the community of San Clemente.
Bibliography	Items 2, 6, 14, 21, 23, 24. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 1.7 square miles. Coastline: 3,500 feet.
Water Use	A nuclear power plant and San Onofre State Beach camping facilities occupy the coastal part of the basin. The inland part is developed for truck crops, irrigated and nonirrigated hay, and commercial flower raising. The area is served by several domestic and irrigation wells.
Water-bearing Sediments	Unconsolidated alluvium of unknown physical characteristics may be about 130 feet thick. At depths of 5 to 55 feet, total and usable ground water storage capacity for this basin and Basin 240 may be about 20,500 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water that occurred about 2.5 miles inland in August 1954 had decreased to less than 100 ppm by May 1969. Intrusion is not evident from the limited data available. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

Table 157. MINERAL ANALYSIS, BASIN 241, SAN ONOFRE VALLEY

Item	Ground Water: U. S. Marine Corps Domestic and Irrigation Well
Base and Meridian	San Bernardino
Location Number	9S/6W-19D1
Date Sampled	5-12-69
Character	CaNaCl
Temperature (°F)	65
Specific Conductance (micromhos at 25° C)	823
pH	7.6
CONSTITUENTS, in parts per million	
Total Dissolved Solids	507
Hardness as $CaCO_3$	
Total	269
Noncarbonate	128
Percent Sodium	36
Bicarbonate: HCO_3	17.1
Boron	0.12
Calcium	73
Carbonate: CO_3	0
Chloride	87
Fluoride	0.4
Magnesium	21
Nitrate: NO_3	19
Potassium	1
Sodium	71
Sulfate: SO_4	1.44

SANTA MARGARITA VALLEY-COASTAL BASIN - BASIN 242

Location	5 miles northwest of the community of Oceanside.
Bibliography	Items 2, 4, 6, 14, 21, 23, 24. Pages 333-334.
Description	Alluvium-filled valley extending northeast to north from the coast. Area: 6.6 square miles. Coastline: 2.5 miles.
Water Use	The basin is primarily a military reservation. Much of the coastal portion is developed to irrigated truck crops and irrigated and nonirrigated hay and grain. Several wells serve domestic and irrigation needs.
Water-bearing Sediments	Recent alluvium that varies from 140 to 200 feet consists in its inland portion of stringers and lenses of unconsolidated clay, silt, sand, gravel, and cobbles and, in its coastal portion, of a lower, permeable deposit overlain by less permeable sediments. Total storage capacity is about 61,600 acre-feet and usable capacity is about 24,000 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and may be in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water that occurred in the coastal part of the basin in November 1952 and in spring, 1968, may have been derived from the percolation of tidal lagoon water. Ground water levels near the coast fluctuate rapidly; if the ground water is drawn down for any length of time, intrusion could be an immediate threat. Movement of ground water is generally westward. However, excessive pumping causes a landward hydraulic gradient.

Table 158. MINERAL ANALYSIS, BASIN 242, SANTA MARGARITA VALLEY-COASTAL BASIN

Item	Ground Water
	U. S. Marine Corps
Base and Meridian	San Bernardino
Location Number	11S/5W-2K1
Date Sampled	5-5-68
Character	NaCl
pH	7.8
CONSTITUENTS, in parts per million	
Total Dissolved Solids	1,448
Total Hardness as $CaCO_3$	472
Bicarbonate: HCO_3	320
Boron	0.1
Calcium	126
Chloride	534
Fluoride	0.59
Magnesium	38
Nitrate: NO_3	1.8
Potassium	6.8
Sodium	358
Sulfate: SO_4	215

SAN LUIS REY VALLEY-MISSION BASIN - BASIN 243

Location	Near the City of Oceanside.
Bibliography	Items 2, 5, 6, 7, 8, 9, 10, 11, 13, 14, 18, 21, 23, 24. Pages 333-334.
Description	Alluvium-filled valley extending northeast from the coast that varies from a steep-walled, stream-cut gorge at the coast to a broad alluvial floodplain farther inland. Area: 5 square miles. Coastline: 0.75 mile.
Water Use	The valley contains an extensive development of truck crops and the town of San Luis Rey. Numerous irrigation and domestic wells pump ground water for local use.
Water-bearing Sediments	Recent alluvium varying in thickness from 165 to 180 feet consists of an upper fine-grained member that partially confines a lower gravelly member. The principal source of ground water is the lower alluvial gravels, although some water is obtained from marine Eocene sands of the La Jolla formation. At depths of 20 to 120 feet, total ground water storage capacity is about 240,000 acre-feet and usable capacity is about 50,000 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	Deposits continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	Under native conditions, ground water moved seaward; but intensive pumping has brought the water table below sea level several miles inland and caused a landward hydraulic gradient that has been characteristic of the basin for several years. Intrusion began in August 1949, and has generally continued since, reaching at least 2 miles inland.

Table 159. MINERAL ANALYSES, BASIN 243, SAN LUIS REY VALLEY-MISSION BASIN

Item	Ground Water		
	George Nagata Domestic & Irrigation Well	City of Oceanside Municipal Well	St. Charles Priory Well
Base and Meridian	San Bernardino	San Bernardino	San Bernardino
Location Number	11S/4W-4N1	11S/4W-18L3	11S/5W-13L1
Date Sampled	2-16-71	2-16-71	2-17-71
Temperature (°F)	68	68	68
Field EC	1,660	2,500	3,400
pH	7.8	8.0	7.4
Chloride (ppm)	300	365	720

San Diego County

LOMA ALTA BASIN - BASIN 244

Location	2 miles south of the City of Oceanside.
Bibliography	Items 2, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending northeast from the coast. Area: 0.75 square mile. Coastline: 1,500 feet.
Water Use	Several small ranches and residences and acreage used to raise truck crops are situated inland. The coastal part of the basin is largely undeveloped.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	One area of degraded ground water that occurred about 3 miles inland in October 1955 and another about 4 miles inland in February 1971 may be derived in part from underlying older Tertiary sediments. Limited data makes any determination of the direction in which the ground water is moving open to question.

Table 160. MINERAL ANALYSIS, BASIN 244, LOMA ALTA

Item	Ground Water
	Fred W. Hampton Well
Base and Meridian	San Bernardino
Location Number	11S/4W-21M1
Date Sampled	2-18-71
Temperature (°F)	69
Field EC	4,000
pH	8.1
Chloride (ppm)	1,100

BUENA VISTA CREEK BASIN - BASIN 245

Location	0.75 mile north of the community of Carlsbad.
Bibliography	Items 2, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending northeast from the coast. Area: 1.0 square mile. Coastline: 0.5 mile.
Water Use	A bird sanctuary and a few small residences are situated in the coastal part of the basin. The upper section is used for stock grazing.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water existed about 2.5 miles inland in November 1954 and about 3.5 miles inland in February 1971. Chloride concentrations in these areas greater than 500 ppm may arise partially from underlying formations. Fresh-water inflow may be sufficient to maintain a seaward hydraulic gradient.

Table 161. MINERAL ANALYSIS, BASIN 245, BUENA VISTA CREEK

Item	Ground Water
	Barry Hayco Well
Base and Meridian	San Bernardino
Location Number	11S/4W-33F1
Date Sampled	2-19-71
Temperature (°F)	66
Field EC	2,600
pH	7.8
Chloride (ppm)	590

San Diego County

AGUA HEDIONDA BASIN - BASIN 246

Location	2 miles south of the community of Carlsbad.
Bibliography	Items 2, 6, 14, 21, 23. Page 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 2 square miles. Coastline: 4,300 feet.
Water Use	The basin is principally developed for cattle grazing.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-Water Intrusion	Chloride concentrations exceeding 400 ppm are characteristic of ground water in this basin. Such water may be derived from older sediments underlying the alluvium. An area of degraded water existed about 4 miles inland in November 1954 and February 1971. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 162. MINERAL ANALYSIS, BASIN 246, AGUA HEDIONDA

Item	Ground Water
	Glenn Bever Well
Base and Meridian	San Bernardino
Location Number	12S/4W-10J1
Date Sampled	2-24-71
Temperature (°F)	70
Field EC	2,150
pH	7.5
Chloride (ppm)	490

San Diego County

ENCINAS BASIN - BASIN 247

Location	3 miles south of the community of Carlsbad.
Bibliography	Items 2, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 0.39 square mile. Coastline: 1,500 feet.
Water Use	The valley is used to raise irrigated hay and grain and pasture land.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	Chloride concentrations from 400 to 600 ppm are characteristic of the ground water in this basin. Such water may be partially derived from older formations that underlie the alluvium. An area of degraded ground water existed about 1.5 miles inland in October 1955 and February 1971. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 163. MINERAL ANALYSIS, BASIN 247, ENCINAS

Item	Ground Water
	C. R. Kelly Domestic, Irrigation, and Stock Well
Base and Meridian	San Bernardino
Location Number	12S/4W-21B1
Date Sampled	2-25-71
Temperature (°F)	68
Field EC	3,600
pH	8.0
Chloride (ppm)	650

SAN MARCOS BASIN - BASIN 248

Location	3 miles north of the town of Encinitas.
Bibliography	Items 2, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled basin extending east from the coast. Area: 3 square miles. Coastline: 0.5 mile.
Water Use	A small turkey ranch is located in this basin. Only limited use is made of the basin's water resources.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	Chloride concentrations in this basin have been steadily increasing since November 1954, when an area of degraded ground water was found about 3.5 miles inland. Sampling in February 1971 identified the same area. Limited information indicates the degradation has been caused by brackish surface water percolating from the lagoonal marshland of Batiquitos Lagoon, not by intruding sea water. The basin appears, from partial data, to have a seaward hydraulic gradient.

Table 164. MINERAL ANALYSIS, BASIN 248, SAN MARCOS

Item	Ground Water
Base and Meridian	San Bernardino
Location Number	12S/4W-36E1
Date Sampled	2-26-71
Temperature (°F)	70
Field EC	8,500
pH	7.8
Chloride (ppm)	1,400

SAN ELIJO BASIN - BASIN 249

Location	3 miles south of the town of Encinitas.
Bibliography	Items 2, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 2.5 square miles. Coastline: 1 mile.
Water Use	A swimming beach, a sport pier, fishing facilities, and numerous commercial establishments and private dwellings occupy the coastal part of the basin. Several ranches and homes and irrigated truck crops and hay occupy the inland portion. Ground water has been developed to serve irrigation and domestic use.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	Chlorides in this basin have been rising steadily in recent years. An area of degraded water was found about 2 to 4 miles inland in August 1954 and March 1971. Limited evidence suggests that ground water near San Elijo Lagoon having chlorides higher than 800 ppm may be derived in part from percolation of poor quality lagoonal water or from older Tertiary sediments underlying the alluvium. A landward hydraulic gradient may also exist in this basin.

Table 165. MINERAL ANALYSES, BASIN 249, SAN ELIJO

Item	Ground Water	
	Carl Croft Irrigation Well	C. M. Walter Well
Base and Meridian	San Bernardino	San Bernardino
Location Number	13S/3W-18B2	13S/4W-25Q1
Date Sampled	3-2-71	3-2-71
Temperature (°F)	69	68
Field EC	3,400	2,800
pH	7.2	8.4
Chloride (ppm)	960	820

SAN DIEGUITO VALLEY - BASIN 250

Location	1.5 miles north of the community of Del Mar.
Bibliography	Items 1, 2, 3, 6, 12, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending northwest from the coast. Area: 5 square miles. Coastline: 6,000 feet.
Water Use	Many residents, a swimming beach and the Del Mar race track occupy the coastal part of the basin. The inland portion contains numerous ranches and acreage used for irrigated truck crops, hay, and grain. Many irrigation and domestic wells serve the area.
Water-bearing Sediments	Unconsolidated alluvium has a maximum thickness of 250 feet. Usable ground water storage capacity is estimated to be 8,000 acre-feet.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and probably are in hydraulic continuity with the ocean.
Sea-water Intrusion	A landward hydraulic gradient, which available information indicates exists at present, has occurred periodically in this basin for a number of years. Areas of degraded ground water were found 5 miles inland in August 1954, along the coast in August 1965, and again 5 miles inland in April 1968. Excessively high chlorides have caused coastal wells to be abandoned. The degraded water, which has reached concentrations of more than 600 ppm, is probably derived from percolating surface water, from underlying older formations, or from intruding sea water, or from a combination of these.

Table 166. MINERAL ANALYSIS, BASIN 250, SAN DIEGUITO VALLEY

Item	Ground Water
	Grist Bros. Well
Base and Meridian	San Bernardino
Location Number	13S/3W-33E1
Date Sampled	4-9-68
Character	NaCl
Temperature (°F)	66
Specific Conductance (micromhos at 25° C)	3,262
pH	7.1
CONSTITUENTS, in parts per million	
Total Dissolved Solids	2,095
Total Hardness as $CaCO_3$	1,025
Bicarbonate: HCO_3	306
Boron	0.14
Calcium	223
Chloride	622
Fluoride	0.6
Magnesium	114
Nitrate: NO_3	1.3
Potassium	9
Sodium	300
Sulfate: SO_4	532

SOLEDAD BASIN - BASIN 251

Location	1.5 miles south of the community of Del Mar.
Bibliography	Items 1, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending southeast from the coast that includes Los Penasquitos, McGonigle, and Carroll Canyons. Area: 3.1 square miles. Coastline: 1 mile.
Water Use	The basin is principally developed for pasture land and small garden crops. Surface water is used for stock watering and for irrigating small crop plantings along creek bottoms. Municipal water is supplied to a part of the basin that lies within the limits of the city of San Diego.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	An area of degraded ground water occurred in the coastal part of the basin in July 1954 and March 1971. Most wells are drilled through the alluvium and into older Tertiary sediments. The high chloride concentrations could be at least partially derived from these older deposits and would not necessarily represent sea-water intrusion.

Table 167. MINERAL ANALYSES, BASIN 251, SOLEDAD BASIN

Item	Ground Water	
	Unnamed Well	Sorrento Sand Company Well
Base and Meridian	San Bernardino	San Bernardino
Location Number	14S/3W-19Q1	14S/4W-25A3
Date Sampled	5-16-69	3-4-71
Character	$NaHCO_3$	-
Temperature (°F)	-	71
Specific Conductance (micromhos at 25°C)	1,299	-
Field EC	-	3,600
pH	8.1	7.4
Chloride (ppm)	-	690
CONSTITUENTS, in parts per million		
Total Dissolved Solids	827	-
Total Hardness as $CaCO_3$	369	-
Bicarbonate: HCO_3	308	-
Boron	0.23	-
Calcium	100	-
Carbonate: CO_3	0	-
Chloride	196	-
Fluoride	0.8	-
Magnesium	29	-
Nitrate: NO_3	3.6	-
Potassium	4	-
Sodium	151	-
Sulfate: SO_4	165	-

San Diego County

LA JOLLA BASIN - BASIN 252

Location	North of the city of La Jolla.
Bibliography	Items 1, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 0.59 square mile. Coastline: 1 mile.
Water Use	Recreational beach facilities, resort motels and hotels, and private residences make up the principal development. City water serves domestic uses.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Deposits may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	No information available. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient throughout the basin.

ROSE CANYON BASIN - BASIN 253

Location	At the northern end of Mission Bay.
Bibliography	Items 1, 6, 14, 21, 23. Pages 333-334.
Description	An alluvium-filled valley. Area: 1.6 square miles (including San Clemente Canyon). Coastline: 1,000 feet.
Water Use	The area around the mouth of the canyon is heavily developed by private residences and commercial establishments.
Water-bearing Sediments	Clays, silts, sands, and gravels form an unconsolidated alluvium of unknown thickness and physical characteristics that is underlain by sandstone and shale of the Rose Canyon formation (Eocene age).
Ground Water Barriers	None known.
Offshore Geology	Sediments may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	High chloride concentrations have been typical of this basin for many years. An area of degraded ground water that existed in the coastal part in July 1954 and March 1971 was probably derived from the older Rose Canyon formation. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 168. MINERAL ANALYSIS, BASIN 253, ROSE CANYON

Item	Ground Water
	G. W. Cornwall Well
Base and Meridian	San Bernardino
Location Number	16S/3W-5E1
Date Sampled	3-9-71
Temperature (°F)	72
Field EC	2,200
pH	8.0
Chloride (ppm)	520

San Diego County

TECOLOTE CREEK BASIN - BASIN 254

Location	At the eastern end of Mission Bay.
Bibliography	Items 1, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley. Area: 0.5 square mile. Coastline: 1,600 feet.
Water Use	Residential and commercial developments occupy the basin.
Water-bearing Sediments	Unconsolidated alluvium of unknown thickness and physical characteristics is underlain by the Rose Canyon formation.
Ground Water Barriers	None known.
Offshore Geology	Sediments may continue offshore and are probably in hydraulic continuity with the ocean.
Sea-water Intrusion	No information available in 1971. An area of degraded ground water existed in the coastal part of this basin in October 1955. Chloride concentrations shown in earlier records as exceeding 100 ppm may be derived from the underlying Rose Canyon formation. Fresh-water inflow may be sufficient to maintain a seaward hydraulic gradient.

SAN DIEGO RIVER VALLEY-MISSION BASIN - BASIN 255

Location	North of the city of San Diego.
Bibliography	Items 1, 14, 18, 19, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast that includes Murphy and Shepard Canyons. Area: 5.5 square miles. Coastline: 3,000 feet.
Water Use	Land in this basin is primarily developed for pasturage and truck crops. Scattered residences and numerous gravel pits and a golf course at the coast also occupy the area. Numerous wells lie in the central and upper portions.
Water-bearing Sediments	Unconsolidated alluvium composed of loosely consolidated sands and gravels containing small amounts of silt and clay averages 80 feet thick. Well consolidated gravels, fine sand, silt, and clay that supply some water to wells compose the Terrace deposits. Pliocene sands and gravels of the San Diego formation make up the underlying and adjacent rocks. Black Mountain volcanics occur at the head of the valley.
Ground Water Barriers	None known.
Offshore Geology	The water-bearing deposits extend beneath Mission Bay and may be open to the bay floor.
Sea-water Intrusion	Intruded sea water was suspected to be the origin of degraded ground water first noted about 1906 along the bayshore margin of Mission Valley. Degraded water was again found along the bay in June 1954 and May 1969 and in several wells lying 4 to 6 miles inland during the 1954-55 intrusion inventory and in May 1970. The high chloride water in this basin may be derived in part from wells that perforate the San Diego formation. But the rising level of degradation characteristics of the area since 1955 is also directly attributable to the intrusion of sea water. Data indicates the presence of a landward hydraulic gradient.

Table 169. MINERAL ANALYSES, BASIN 255, SAN DIEGO RIVER VALLEY-MISSION BASIN

Item	Ground Water		
	Tru-Block Co. Industrial Well	San Diego Consolidated Company Well	River Valley Golf Course Well
Base and Meridian	San Bernardino	San Bernardino	San Bernardino
Location Number	16S/2W-17H1	16S/3W-13Q1	16S/3W-21J1
Date Sampled	5-14-70	5-15-70	5-15-69
Character	NaCaCl	NaCaCl	NaCaCl
Temperature (°F)	-	67	69
Specific Conductance (micromhos at 25°C)	4,020	2,293	5,967
pH	8.0	7.8	7.6
CONSTITUENTS, in parts per million			
Total Dissolved Solids	2,749	1,436	3,936
Total Hardness as $CaCO_3$	1,224	515	1,599
Bicarbonate: HCO_3	316	240	419
Boron	0.19	0.19	0.3
Calcuium	293	111	313
Carbonate: CO_3	0	0	0
Chloride	997	491	1,640
Fluoride	0.36	0.55	0.9
Magnesium	120	58	199
Nitrate: NO_3	102	1	5
Potassium	3	2.7	18
Sodium	348	260	718
Sulfate: SO_4	253	194	498

LAS CHOLLAS BASIN - BASIN 256

Location	2 miles north of National City.
Bibliography	Items 1, 6, 14, 21, 23. Pages 333-334.
Description	One of five small adjacent alluvium-filled valleys extending north from San Diego Bay. Area: 1 square mile. Coastline: 1,000 feet.
Water Use	A large naval installation and many small businesses and homes are situated near the mouth of the valley. A dairy farm and housing tracts lie in the central and upper portions.
Water-bearing Sediments	Loosely consolidated gravels, sands, and silts form the unconsolidated alluvium of unknown thickness and physical characteristics.
Ground Water Barriers	None known.
Offshore Geology	Sediments may continue beneath San Diego Bay and may be in hydraulic continuity with the saline bay water.
Sea-water Intrusion	An area of degraded ground water existed about 3 miles inland in July 1954 and 1971. No information is available for the coastal part of the basin in these years. Ground water in this area with a chloride concentration exceeding 100 ppm is probably derived from underlying older formations. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 170. MINERAL ANALYSIS, BASIN 256, LAS CHOLLAS

Item	Ground Water
	Clingman Dairy Domestic, Stock, and Industrial Well
Base and Meridian	San Bernardino
Location Number	17S/2W-4B1
Date Sampled	3-10-71
Temperature (°F)	76
Field EC	1,300
pH	7.0
Chloride (ppm)	140

San Diego County

SOUTH LAS CHOLLAS BASIN - BASIN 257

Location	1.5 miles north of National City.
Bibliography	Items 1, 6, 14, 21, 23. Page 333-334.
Description	Alluvium-filled valley extending northeast from San Diego Bay. Area: 2 square miles. Coastline: 1,200 feet.
Water Use	A large naval installation lies at the valley mouth; numerous homes and businesses are located throughout the valley. Some small farms occupy the central and upper portions.
Water-bearing Sediments	Loosely consolidated sands, gravels, silts, and clays compose the unconsolidated alluvium of unknown thickness and physical characteristics that is underlain and surrounded by southwest-dipping beds of Pliocene sandstone and conglomerate of the San Diego formation.
Ground Water Barriers	None known.
Offshore Geology	Sediments may continue beneath San Diego Bay and may be in hydraulic continuity with saline bay water.
Sea-water Intrusion	No information is available for 1954 or 1971. Fresh-water inflow is probably sufficient to hold ground water levels at or above sea level and to maintain a seaward hydraulic gradient throughout the basin.

SWEETWATER VALLEY - BASIN 260

Location	1 mile north of the community of Chula Vista.
Bibliography	Items 1, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 2.6 square miles. Coastline: 0.75 mile.
Water Use	A gravel plant, numerous small residences, and a few business establishments lie in the lower end of the valley. The central and upper portions contain chiefly truck gardens and citrus groves.
Water-bearing Sediments	Loosely consolidated sands, gravels, silts, and clays compose the unconsolidated alluvium of unknown thickness and physical characteristics that is underlain and surrounded by southwest-dipping sandstone and conglomerate beds of the Pliocene San Diego formation.
Ground Water Barriers	None known.
Offshore Geology	Sediments may extend beneath San Diego Bay and may be open to saline bay water.
Sea-water Intrusion	An area of degraded ground water existed about 2 miles inland in July 1954 and another area was found about 3 miles inland in May 1970. High chloride water may originate in part from wells that perforate the San Diego formation. However, chloride concentrations have been steadily rising since the early 1950s, a condition that could be attributed to possible sea-water intrusion. Limited data indicate that a landward hydraulic gradient may exist in this basin.

Table 171. MINERAL ANALYSIS, BASIN 260, SWEETWATER VALLEY

Item	Ground Water
	Bonita Golf Course Well
Base and Meridian	San Bernardino
Location Number	17S/2W-27R1
Date Sampled	5-5-70
Character	NaCl
Temperature (°F)	-
Specific Conductance (micromhos at 25°C)	4,604
pH	7.5
CONSTITUENTS, in parts per million	
Total Dissolved Solids	3,123
Total Hardness as $CaCO_3$	1,303
Bicarbonate: HCO_3	415
Boron	0.34
Calcium	245
Carbonate: CO_3	0
Chloride	1,200
Fluoride	0.64
Magnesium	168
Nitrate: NO_3	22
Potassium	4.7
Sodium	492
Sulfate: SO_4	345

SWEETWATER VALLEY - BASIN 260

Location	1 mile north of the community of Chula Vista.
Bibliography	Items 1, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 2.6 square miles. Coastline: 0.75 mile.
Water Use	A gravel plant, numerous small residences, and a few business establishments lie in the lower end of the valley. The central and upper portions contain chiefly truck gardens and citrus groves.
Water-bearing Sediments	Loosely consolidated sands, gravels, silts, and clays compose the unconsolidated alluvium of unknown thickness and physical characteristics that is underlain and surrounded by southwest-dipping sandstone and conglomerate beds of the Pliocene San Diego formation.
Ground Water Barriers	None known.
Offshore Geology	Sediments may extend beneath San Diego Bay and may be open to saline bay water.
Sea-water Intrusion	An area of degraded ground water existed about 2 miles inland in July 1954 and another area was found about 3 miles inland in May 1970. High chloride water may originate in part from wells that perforate the San Diego formation. However, chloride concentrations have been steadily rising since the early 1950s, a condition that could be attributed to possible sea-water intrusion. Limited data indicate that a landward hydraulic gradient may exist in this basin.

Table 171. MINERAL ANALYSIS, BASIN 260, SWEETWATER VALLEY

Item	Ground Water
	Bonita Golf Course Well
Base and Meridian	San Bernardino
Location Number	17S/2W-27R1
Date Sampled	5-5-70
Character	NaCl
Temperature (°F)	-
Specific Conductance (micromhos at 25°C)	4,604
pH	7.5
CONSTITUENTS, in parts per million	
Total Dissolved Solids	3,123
Total Hardness as $CaCO_3$	1,303
Bicarbonate: HCO_3	415
Boron	0.34
Calcium	245
Carbonate: CO_3	0
Chloride	1,200
Fluoride	0.64
Magnesium	168
Nitrate: NO_3	22
Potassium	4.7
Sodium	492
Sulfate: SO_4	345

San Diego County

OTAY VALLEY - BASIN 261

Location	Near South San Diego at the southernmost end of San Diego Bay.
Bibliography	Items 1, 6, 14, 21, 23. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 5 square miles. Coastline: 3,700 feet.
Water Use	Several gravel plants and numerous small homes and businesses occupy the lower end of the valley. Truck gardens and pasture land lie in the middle and upper portions.
Water-bearing Sediments	Loosely consolidated sands, gravels, silts, and clays compose the unconsolidated alluvium of unknown thickness and physical characteristics that is underlain and surrounded by southwest-dipping sandstone and conglomerate beds of the Pliocene San Diego formation.
Ground Water Barriers	None known.
Offshore Geology	Sediments may extend beneath the San Diego Bay and may be in hydraulic continuity with saline bay water.
Sea-water Intrusion	An area of high-chloride water that existed in the bayward section in July 1954 and May 1970 was most probably derived from the older, underlying San Diego formation. High chloride concentrations have been characteristic of this basin for a number of years. Fresh-water inflow is probably sufficient to maintain a seaward hydraulic gradient.

Table 172. MINERAL ANALYSIS, BASIN 261, OTAY VALLEY

Item	Ground Water: R. Eggers Irrigation Well
Base and Meridian	San Bernardino
Location Number	18S/2W-21H1
Date Sampled	5-13-70
Character	NaCl
Temperature (°F)	77
Specific Conductance (micromhos at 25°C)	2,495
pH	7.8
CONSTITUENTS, in parts per million	
Total Dissolved Solids	1,650
Total Hardness as $CaCO_3$	652
Bicarbonate: HCO_3	159
Boron	0.14
Calcium	155
Carbonate: CO_3	0
Chloride	616
Fluoride	0.32
Magnesium	65
Nitrate: NO_3	1
Potassium	4.7
Sodium	244
Sulfate: SO_4	168

San Diego County

TIA JUANA BASIN - BASIN 262

Location	North of the International Boundary between Mexico and the United States.
Bibliography	Items 1, 6, 7, 8, 9, 10, 11, 14, 17, 20, 22. Pages 333-334.
Description	Alluvium-filled valley extending east from the coast. Area: 6.6 square miles. Coastline: 3 miles.
Water Use	Many ranches and farms raise truck crops by extensive irrigation.
Water-bearing Sediments	Unconsolidated alluvium composed of gravel, sand, silt, and clay is underlain by sediments of Pleistocene and Pliocene age. A terrace of Pleistocene age, covered by a veneer of alluvium, lies along the north side of the valley. Another buried terrace may exist on the south side of the Tijuana River. Two aquifers -- a deep, water-bearing zone overlain by a shallow zone -- underlie the western part of the valley. Only one zone appears to exist in the eastern part. Sediments lying between the deep and shallow zones, although not totally impervious, are more impervious than are the coarse, underlying gravels. The dense upper material partially confines the ground water beneath it so that deep wells in this area display artesian characteristics.
Ground Water Barriers	None known.
Offshore Geology	Water-bearing deposits along the ocean margin of the valley extend beneath the continental shelf and are in contact with the ocean floor. These deposits are apparently open to the ocean.
Sea-water Intrusion	An area of degraded ground water extended about one mile inland in August 1955, and since 1955 water levels along the coast have been below sea level and a landward hydraulic gradient has existed. Well sampling in May 1970 indicated the presence of degraded water. Intrusion of sea water is imminent. A probable source of degradation is the poor quality water in Tertiary sediments that underlie and are adjacent to the basin. This water may invade the basin when the water table is drawn down by excessive pumping.

Table 173. MINERAL ANALYSES, BASIN 262, TIA JUANA BASIN

Item	Ground Water	
	Robert Egger Irrigation Well	Knox Dairy Farm Irrigation Well
Base and Meridian	San Bernardino	San Bernardino
Location Number	18S/2W-33L10	19S/2W-5Q2
Date Sampled	5-13-70	5-13-70
Temperature (°F)	96	-
Specific Conductance (micromhos at 25°C)	2,130	3,929
pH	8.3	7.8
CONSTITUTENTS, in parts per million		
Total Dissolved Solids	1,277	2,699
Total Hardness as $CaCO_3$	287	1,087
Bicarbonate: HCO_3	336	306
Boron	0.14	0.39
Calcium	38	116
Carbonate: CO_3	13	0
Chloride	339	876
Fluoride	0.56	0.81
Magnesium	47	88
Nitrate: NO_3	0	2
Potassium	12	3.5
Sodium	340	428
Sulfate: SO_4	253	482

APPENDIX A

ALPHABETICAL INDEX OF COASTAL GROUND WATER BASINS IN CALIFORNIA

ALPHABETICAL INDEX OF COASTAL GROUND WATER BASINS IN CALIFORNIA

ALPHABETICAL INDEX OF COASTAL GROUND WATER BASINS IN CALIFORNIA (cont.)

ALPHABETICAL INDEX OF COASTAL GROUND WATER BASINS IN CALIFORNIA (cont.)

ALPHABETICAL INDEX OF COASTAL GROUND WATER BASINS IN CALIFORNIA (cont.)

APPENDIX B

NUMERICAL INDEX OF COASTAL GROUND WATER BASINS IN CALIFORNIA

NUMERICAL INDEX OF COASTAL GROUND WATER BASINS IN CALIFORNIA

Basin Nos.	County
1 through 4	Del Norte
5 through 19	Humboldt
20 through 54	Mendocino
55	Mendocino and Sonoma
56 through 60	Sonoma (Coastal)
61 through 79	Marin (Coastal)
80 through 86	Marin (Bay Shoreline)
87	Sonoma and Marin (Bay Shoreline)
88	Sonoma, Napa, and Solano
89 through 92	Solano
93	Solano, Sacramento, San Joaquin, and Contra Costa
93-A through 104	Contra Costa
105	Contra Costa, Alameda, Santa Clara, and San Mateo
106	San Mateo (Bay Shoreline)
107 through 111	San Francisco (Bay Shoreline)
112	San Francisco (Coastal)
113 through 125	San Mateo (Coastal)
126 through 147	Santa Cruz
148	Santa Cruz and Monterey
149 through 155	Monterey
156 through 176	San Luis Obispo
177	San Luis Obispo and Santa Barbara
178 through 215	Santa Barbara
216 through 220	Ventura
221 through 234	Los Angeles
235 through 239	Orange
240 through 262	San Diego

APPENDIX C

LIST OF TABLES 7-173, STATUS OF SEA-WATER INTRUSION BY COUNTIES AND MINERAL ANALYSES BY BASIN

APPENDIX C

TABLE 7 THROUGH TABLE 173, "STATUS OF SEA-WATER INTRUSION" (BY COUNTY) AND "MINERAL ANALYSES" (BY BASIN)

APPENDIX D

MECHANICS OF SEA-WATER INTRUSION

APPENDIX D

MECHANICS OF SEA-WATER INTRUSION

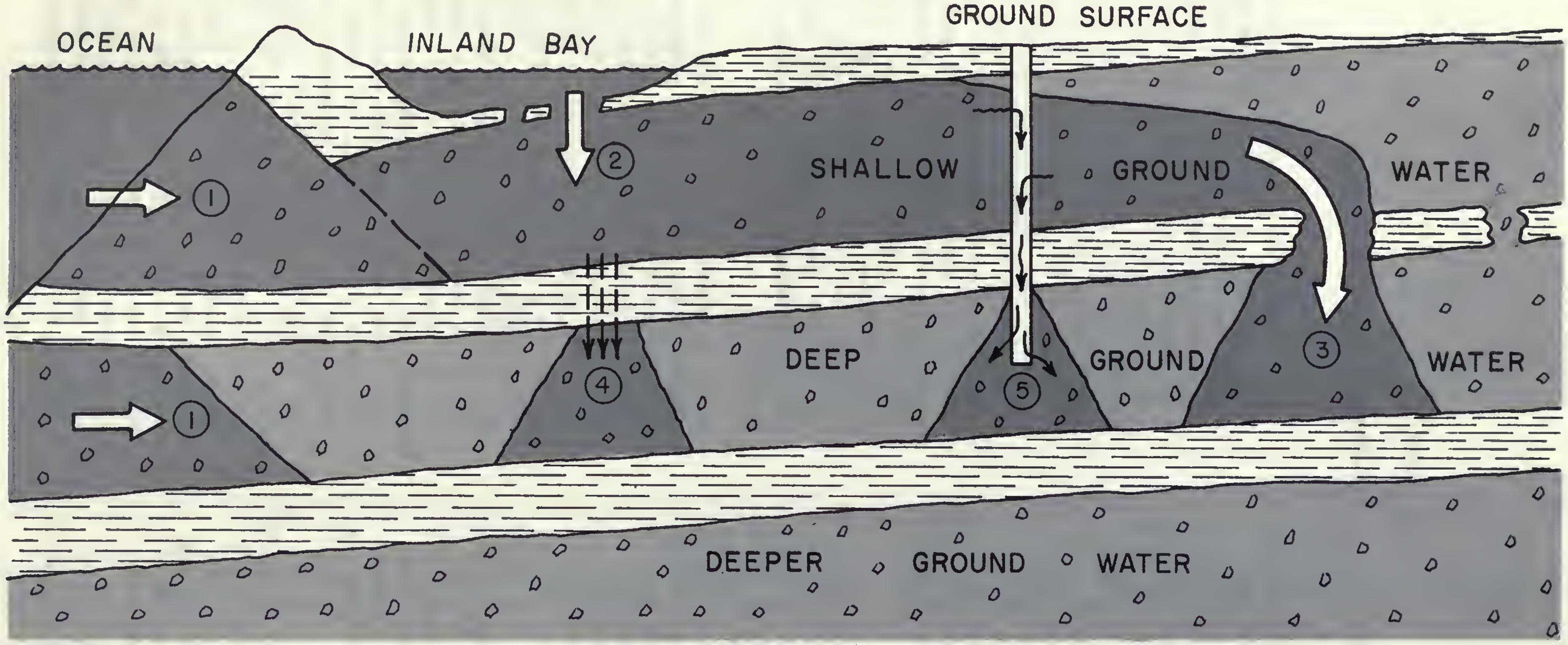
Two fundamental conditions must exist before a ground water basin can be intruded by sea water. First, the water-bearing materials comprising the basin must be in hydraulic continuity with sea water, either directly on the ocean floor or along a river, estuary, or bay that contains sea water or brackish water. Second, ground water levels in the coastal area must be below sea level and the normal seaward ground water gradient must have been reversed, or at least must be too flat to counteract the greater density of sea water.

In considering the intrusion of sea water into a fresh-water aquifer, the significant factor is that saline water is about 1.025 times heavier than fresh water and, when the two meet within a permeable formation, the lighter fresh water tends to float above the heavier (more dense) saline water. This property is relatively unimportant in water that is only slightly saline, but it becomes critical as the level of salinity approaches that of sea water. An additional problem lies in the fact that, under ordinary conditions, when a body of fresh water and one of sea water touch, the two liquids tend to diffuse almost instantaneously. When they touch within a permeable formation, this natural tendency is greatly impeded.

A floating body of fresh water conforms to Archimedes' law of buoyancy, which states that any floating object will displace its own weight of the medium in which it floats. As applied to relationships between fresh and sea water in ground water basins, this principle is commonly known as the Ghyben-Herzberg principle, which states in general that a body of fresh water floating over a body of saline water assumes a shape in which the depth of its lower surface below sea level is everywhere 40 times its surface elevation above sea level. This principle determines the minimum elevation a fresh-water table must attain to prevent sea-water intrusion. In theory, a fresh-water table maintained at the proper elevation above mean sea level can hold an intruding body of saline water in a stationary position (in equilibrium with the body of fresh water). In complex multiple aquifer systems which occur in Orange, Los Angeles, Ventura, and Monterey Counties and in the San Francisco Bay area, the Ghyben-Herzberg principle seems less apparent.

Along a coastal aquifer, the intruding saline water assumes the shape of a prism having an inclined surface that always slopes landward and that advances or recedes in response to changes in the hydraulic gradient. Because of its shape, this prism of ocean water is called the sea-water wedge. Advance and retreat of the wedge commences at its toe, the position of the upper end of the fresh-water/sea-water interface remaining fixed at the shoreline until all fresh water near the coast is depleted to sea level. At that time, the upper end of the interface commences its advance and the entire edge moves as a body. Theoretically, no flow occurs across the interface at the sea-water wedge, although model and field studies do indicate the existence of a mixing zone. The thickness of the mixing zone may vary, becoming greater in an area of fluctuating tidal influence or where pumping causes frequent changes in the hydraulic gradient.

TYPES OF SEA-WATER INTRUSION IN COASTAL GROUND WATER BASINS



EXPLANATION

- CLAY BEDS
- AQUIFERS
- FRESH WATER
- SALINE WATER

1. DIRECT INTRUSION FROM OCEAN INTO COASTAL AQUIFERS AS A SEA-WATER WEDGE.
2. DIRECT MOVEMENT OF BAY WATER THROUGH NATURAL OR MAN-MADE BREAKS IN CLAY BEDS.
3. SPILLING OF DEGRADED SHALLOW AQUIFER WATERS INTO DEEPER AQUIFERS.
4. SLOW DOWNWARD MOVEMENT OF SALINE WATER THROUGH CLAY LAYERS INTO UNDERLYING AQUIFERS.
5. SPILLING OR CASCADING OF SALINE WATER INTO UNDERLYING AQUIFERS THROUGH IMPROPERLY CONSTRUCTED OR ABANDONED WELLS.

Sea-water intrusion can occur in several ways in a coastal or bay ground water basin (see sketch). The mechanisms all involve two events: the reduction of water level elevations and the development of a landward hydraulic gradient that allows the sea water to move inland. Under the classic sea-water wedge intrusion mechanism, there is a balance between inflow, outflow, and changes in storage. Part of the outflow is fresh water that leaks to the ocean, an action that stabilizes the salt-water/fresh-water interface. As ground water is developed, water levels lower to accommodate the new conditions of supply and demand, and the interface moves inland. While this occurs--first from the offshore extension of the water-bearing materials and then inland from the shoreline--saline water may degrade fresh water in the following ways:

By spilling of degraded water from shallow aquifers into deeper aquifers

By slow downward movement of saline water through clay layers into underlying aquifers

By spilling or cascading of saline water into underlying aquifers through improperly constructed or improperly abandoned wells

An additional sea-water intrusion mechanism that frequently occurs in coastal and inland bay areas is direct downward movement of saline and brackish tidal or inland bay water through natural or man-made breaks in underlying clay layers. This type of intrusion may be going on simultaneously with movement of the classic sea-water wedge, or it may be the principal mechanism of intrusion.

Increased salinity of ground water in a coastal basin does not necessarily establish the existence of intruded sea water. Such increases may be attributable entirely or partially to other factors, some of the more significant of which are:

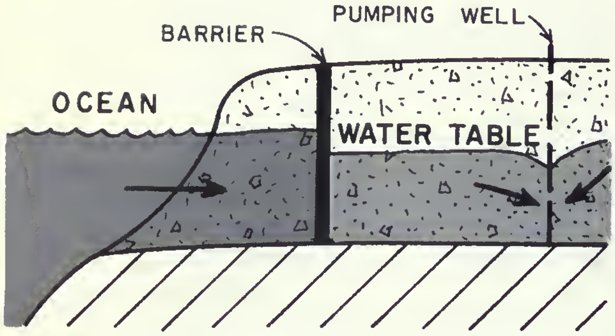
Use and reuse and disposal of poor quality wastes without sufficient outflow, causing an adverse salt balance

Lateral or upward migration of brines or degraded water contained in formations flanking or underlying the ground water basin

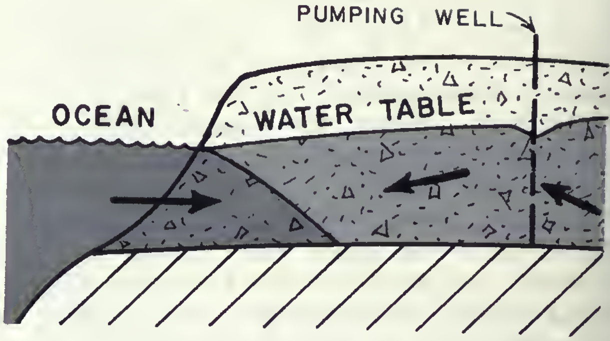
Downward seepage of mineralized surface water from streams, lakes, and lagoons

Fixing the true causes for rises in salinity of ground water is sometimes difficult. In some instances, chemical analyses and the ratios of certain constituent ions may prove helpful in identifying sea water. At the present level of knowledge, however, chemical analyses can be used to distinguish sea water from certain oil-field brines or connate water only with the greatest difficulty.

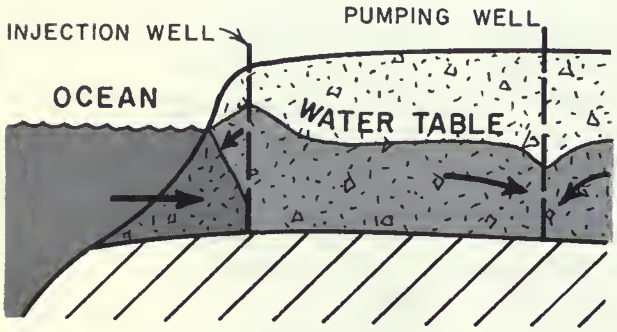
POTENTIAL PROTECTIVE MEASURES



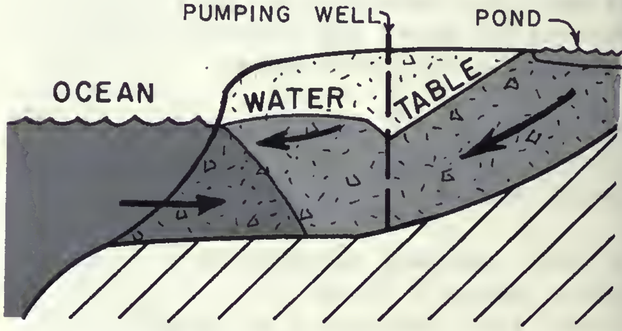
MAN-MADE PHYSICAL BARRIER



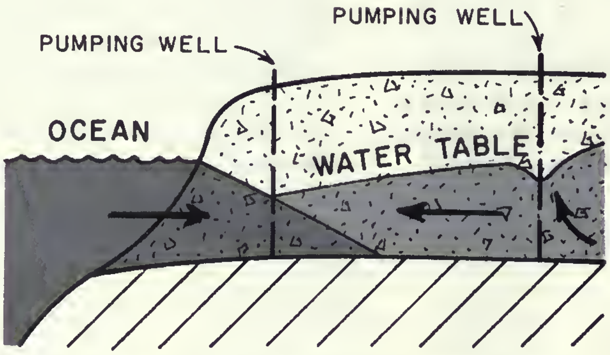
CONTROLLED PUMPING



INJECTION BARRIER



ARTIFICIAL RECHARGE



PUMPING TROUGH BARRIER